Trinity Alps Wilderness Prescribed Fire Project

Soil/Geology/Hydrology Report

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Introduction

The Shasta-Trinity National Forest proposes a prescribed fire project located in the Upper New River Watershed within the Trinity Alps Wilderness. The area is adjacent to wildland urban interface (WUI) and has experienced multiple wildfires in the last few decades with notable percentages of moderate or high intensity (see Fire, Fuels, Air Quality and Vegetation Report). These wildfires have increased the risk of cumulative watershed impacts in the New River Watershed. The project area encompasses 58,349 acres in the upper New River Watershed.

This report address impacts to soils, geology, and hydrologic resources anticipated as a result of the Trinity Alps Wilderness Prescribed Fire Project. The project terrain is predominantly montane with steep slopes and elevations ranging from 1,500 feet to 6,700 feet. Annual precipitation ranges from 50 – 70 inches with 90%

of the precipitation falling between October and April. Snow frequently accumulates above 4000 feet. Elevations between 3000-4000 frequently experience rain on snow events that result in high energy flashy flow events that make lower elevations susceptible to extreme erosion events such as debris flows.

This report describes:

- The laws that are relevant to earth resources management on the Shasta-Trinity National Forest;
- The hydrologic, geologic, and soils environment affected by the alternatives;
- The sections of each proposed alternative that are relevant to water, geology, and soils;
- The direct, indirect and cumulative environmental consequences of the alternatives.

Regulatory Framework for Water

1. Federal Water Pollution Control Act of 1972 (Public Law 92-500) as amended in 1977 (Public Law 95-217) and 1987 (Public Law 100-4) – also known as the Federal Clean Water Act (CWA):
    a. CWA Sections 208 and 319 recognize the need for control strategies for non-point source pollution.
    b. The Region 5 Best Management Practices program is designed to specifically address nonpoint source pollution issues. Refer to Appendix B of this report for the project specific pertinent measures that control non-point source pollution.
    c. CWA Section 303(d) requires the State of California to compile a biannual list of waterbodies that are determined to be either impaired (not fully meeting water quality standards) or threatened (likely to violate standards in the near future). These waters are targeted and scheduled for development of water quality improvement strategies on a priority basis.
    d. CWA Section 305(b) requires that states assess the condition of their waters and produce a biannual report summarizing the findings.
2. Environmental Protection Agency (EPA) – The Trinity River and its associated tributaries in this area are on the California 303d list as an impaired water body, and a pollution reduction plan (Total Maximum Daily Load-TMDL) is in place for the river and the tributary watersheds (US Environmental Protection Agency 2001). The background sedimentation levels in the New River watershed (1,592 tons per square mile per year), which were used as reference levels to establish the Trinity River TMDL, which limits sedimentation to increase no more than 25% to insure protection of the local aquatic resources.
3. Wild and Scenic Rivers Act (1968) – The outstandingly remarkable values of rivers eligible or suitable to be included in the system must be carefully managed. Any management activities that could negatively impact these values should not be conducted.

The New River is designated as a Wild and Scenic River from approximately 1,000 feet below the confluence of Virgin and Slide creeks to the mouth of the river near Burnt Ranch. There are three separate designations on Wild and Scenic Rivers: recreation, scenic, and wild. Each designation carries a unique set of standards that regulate activities on federal lands within 25 miles of the river. Portions of the New River are included in each designation. Segments of Virgin Creek within the project area have been recommended for Wild and Scenic status (Refer to the Recreation, Scenery and Wilderness Report for more information).

4. California Porter-Cologne Water Quality Act – This act requires regulation and control of waste discharges on lands that include agricultural and timber lands in a regional basin plan complete with water quality goals and objectives.

The water quality objectives specific for this project area can be found in the North Coast Regional Water Quality Control Board Basin Plan and Water Quality Objectives (May 2011).

a. The Porter Cologne Act has 3 authorities for controlling pollution discharge; Waivers for Waste Discharge Requirements are one of these. The policy in place for the US Forest Service is to adopt the California Regional Water Quality Control Board North Coast Region Order No. R1-2010-0029 Waiver of Waste Discharge Requirements For Nonpoint Source Discharges Related to Certain Federal Land Management Activities on National Forest System Lands in the North Coast Region.

Prescribed burning is considered a Category B, Moderate Risk project under the 2010 Waiver with the North Coast Water Board that requires application for a project specific waiver which would occur at the time the decision is made for how to move forward with this project.

5. <u>Shasta-Trinity National Forest Land and Resource Management Plan (1995)</u> – Applicable Standards and Guidelines are described below:
   a. Riparian 17a: The Riparian Reserve Standards and Guidelines (Management Prescription section, Riparian Reserves) apply to all 2.1 million acres of the Shasta-Trinity National Forests.
   b. Riparian 17c: Identify and treat riparian areas that are in a degraded condition.
   c. Soil and Water 18a: Analyze each land disturbing project for its effect on the appropriate 2nd or 3rd order watershed (average size about 1,000 acres), to prevent excessive cumulative impacts on stream channel and condition.
   d. Soil and Water 18a2: The threshold of concern (TOC) for a watershed is expressed as the percentage of disturbed or compacted soil area within a total watershed. The Equivalent Roaded Area (ERA) threshold equals 18% in low sensitivity watersheds, 16% in moderate sensitivity watersheds, and 14% in high sensitivity watersheds and 12% in extremely sensitive watersheds.
   e. Soil and Water 18a3: Projects on National Forest lands should not increase the ERA above the proportional share (depending on land ownership) of the TOC unless, as part of the project, existing ERAs would be reduced or the ERA recovery factor would be improved.
   f. Soil and Water 18c: Implement Best Management Practices (BMPs) for protection or improvement of water quality, as described in the Water Quality Management Handbook (USDA Forest Service 2011) for applicable management activities. Determine specific practices or techniques during project-level planning using information obtained from onsite soil, water, and geology investigations.
   g. Water 39: Maintain or improve water quality and quantity to meet fish habitat requirements and domestic use needs.
   h. Water 40: Maintain water quality to meet or exceed applicable standards and regulations.
6. <u>Aquatic Conservation Strategy (ACS) of the Northwest Forest Plan (1999) as incorporated into the STNF LRMP</u> – The purpose of the ACS is to “maintain and restore the ecological health of watersheds and aquatic ecosystems contained within them on public lands” and to “prevent further degradation and restore habitat over broad landscapes as opposed to individual projects or small watersheds” (USDA Forest Service and USDI Bureau of Land Management 1994). The Aquatic Conservation Strategy Objectives are below (see Appendix B in the EA for a detailed description regarding how this project relates to ACS objectives):
   a. Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.

b. Maintain and restore spatial and temporal connectivity within and between watersheds.

c. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

d. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems.

e. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements include timing, volume, rate and character of sediment input, storage, and transport.

f. Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing.

g. Maintain and restore timing variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

h. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration, and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

i. Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

7. Forest Service Manual (FSM) 2532.02 and 2532.03 – These guidelines describe the objectives and policies relevant to protection (and, where needed, improvement) of water quality on National Forest System lands so that designated beneficial uses are protected.

8. FSM 2554 – The National Forest Management Act requires that lands be managed to ensure the maintenance and long-term soil productivity, soil hydrologic function, and ecosystem health. Soil quality is maintained when erosion, compaction, displacement, rutting, burning, and loss of organic matter are maintained within defined soil quality standards.

While the New River is considered a reference watershed (US Environmental Protection Agency (EPA) 2001) and a key watershed (USDA Forest Service and USDI Bureau of Land Management 1994) the antidegradation provisions of the CWA and North Coast Water Board Basin Plan prohibit an "increase in pollution." In other words, high quality waters must be maintained as such. In particular, resource managers must continue to prevent, protect and restore conditions in the reference subwatersheds that provide critical refugia for aquatic species while habitat in other areas of the basin improve, in part due to TMDL implementation.

Regulatory Framework for Geology

1. Organic Administrative Act of June 4, 1897, as Amended (30 Stat. 34, as Supplemented and Amended; 16 U.S.C. 473-478, 482-482(a), 551. (FSM 2501.1.) This act authorizes the Secretary of Agriculture to issue rules and regulations for the occupancy and use of the National forests. This is the basic authority for issuing special use permits for the collection of vertebrate paleontological resources for scientific and educational purposes on National Forest System lands.

2. Preservation of American Antiquities Act of June 8, 1906 (34 Stat. 225; 16 U.S.C. 431 et seq.). (FSM 2361.01.) This act authorizes permits for archeological and paleontological exploration involving excavation, removal, and storage of objects of antiquity or permits necessary for

investigative work requiring site disturbance or sampling which results in the collection of such objects.

3. Multiple Use – Sustained Yield Act of June 12, 1960 (MUSY) (74 Stat. 215; 16 U.S.C. 528-531). (FSM 2501.1.) This act requires due consideration for the relative values of all resources and implies that the administration of nonrenewable resources must be considered.

4. Watershed Protection and Flood Prevention Act of August 4, 1954, as Amended (68 Stat. 666; 16 U.S.C. 1001). (FSM 2501.1.) This act authorizes the Secretary of Agriculture to share costs with other agencies in recreational development, ground-water recharge, and water-quality management, as well as the conservation and proper use of land.

5. Federal Water Pollution Control Act of July 9, 1956, as Amended (33 U.S.C. 1151) (FSM 2501.1); Federal Water Pollution Control Act Amendments of 1972 (86 Stat. 816) (FSM 2501.1), and Clean Water Act of 1977 (91 Stat. 1566; 33 U.S.C. 1251). (FSM 2501.1, 7440.1.) These acts are intended to enhance the quality and value of the water resource and to establish a national policy for the prevention, control, and abatement of water pollution. Ground water information, including that concerning recharge and discharge areas, and information on geologic conditions that affect ground water quality are needed to carry out purposes of these acts.

6. Wilderness Act of September 3, 1964 (78 Stat. 890; 16 U.S.C. 1131-1136). (FSM 2501.1.) This act describes a wilderness as an area which may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value. These geological features are generally identified for wilderness classification purposes.

7. National Forest Roads and Trails Systems Act of October 13, 1964 (78 Stat. 1089; 16 U.S.C. 532-538). (FSM 7701.1.) This act provides for the construction and maintenance of an adequate system of roads and trails to meet the demands for timber, recreation, and other uses. It further provides that protection, development, and management of lands will be under the principles of multiple use and sustained yield of product and services (16 U.S.C. 532). Geologic conditions influence the final selection of route locations.

8. Mining and Minerals Policy Act of December 31, 1970 (84 Stat. 1876; 30 U.S.C. 21a). This act provides for the study and development of methods for the disposal, control, and reclamation of mineral waste products and the reclamation of mined lands. This requires an evaluation of geology as it relates to ground water protection and geologic stability.

9. Resource Conservation and Recovery Act of 1976 (RCRA) (90 Stat. 2795; 42 U.S.C. 6901) as Amended by 92 Stat. 3081. This act, commonly referred to as the Solid Waste Disposal Act, requires protection of ground water quality and is integrated with the Safe Drinking Water Act of December 16, 1974, and Amendments of 1977 (42 U.S.C. 300(f)) (FSM 7420.1).

10. Federal Cave Resources Protection Act of 1988 (102 Stat. 4546; 16 U.S.C. 4301 et seq.). This act provides that Federal lands be managed to protect and maintain, to the extent practical, significant caves.

11. Shasta-Trinity National Forest Land and Resource Management Plan. Directs use of riparian reserves, streamside management zones, and stream management zones in part because of unstable and potentially unstable areas, including inner gorges. Directs avoidance of land disturbing activities with "known" or "suspected" instability. The LRMP and directs project analysis to identify and evaluate areas of known or suspected instability as a part of project

planning. Protect areas with a high probability of mass wasting from ground disturbing activities.

Regulatory Framework for Soil

1. The Organic Administration Act of 1897 (16 U.S.C. 473-475). Authorizes the Secretary of Agriculture to establish regulations to govern the occupancy and use of National Forests and "…to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States."

3. The Multiple-Use, Sustained-Yield Act of 1960 (P.L. 86-517, 74 Stat. 215; 16 U.S.C. 528-531). States that the National Forests are to be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes. This Act directs the Secretary to manage these resources in the combination that will best meet the needs of the American people; providing for periodic adjustments in use to conform to changing needs and conditions; and harmonious and coordinated management of the resources without impairment of the productivity of the land. Sustained yield means achieving and maintaining into perpetuity a high-level annual or regular periodic output of renewable resources without impairment of the productivity of the land.

4. The National Environmental Policy Act (NEPA) of 1969 (16 U.S.C. 4321). Declares it is the policy of the Federal Government to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans. The Act requires agencies to analyze the physical, social, and economic effects associated with proposed plans and decisions, to consider alternatives to the action proposed, and to document the results of the analysis.

5. The Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 (16 U.S.C. 1600-1614) (as amended by National Forest Management Act (NFMA) of 1976 (16 U.S.C. 472a). States that the development and administration of the renewable resources of the National Forest System are to be in full accord with the concepts for multiple use and sustained yield of products and services as set forth in the Multiple-Use Sustained Yield Act of 1960. The Act requires the maintenance of productivity of the land and the protection and, where appropriate, improvement of the quality of the soil and water resources. The Act specifies that substantial and permanent impairment of productivity must be avoided and has far-reaching implications for watershed management in the National Forest System. This Act as amended contains the following sections and provisions pertinent to maintaining a sound soil management program:

a. Section 3 paragraph 6b. This section directs the Secretary of Agriculture to make, and keep current, a comprehensive survey and analysis of conditions of, and requirements for, forest and rangelands of the United States, including a determination of the present and potential productivity of the land.

b. Section 5. This section directs the Secretary of Agriculture to develop and maintain on a continuing basis, a comprehensive and appropriately detailed inventory of all National Forest System lands and renewable resources.

c. Section 6 paragraph k. This section directs the Secretary of Agriculture to identify lands within the management area which are not suited for timber production.

Forest Service Manual 2550 defines soil terminology and covers requirements for analysis.
The Shasta-Trinity National Forest Land and Resource Management Plan (LRMP) establishes Forest-wide management direction, and Standards and Guidelines in carrying out project activities. Management direction pertaining to soils includes the following:

- Develop specific soil evaluation and mitigation measures for each project that has the potential to impact the soil resource.
- Develop and apply erosion control plans to road construction, mining, recreation developments, and other site disturbing projects. Use the Soils and Geologic Resource Inventories for predicting the need and extent for erosion control measures.
- Protect long-term soil productivity in controlled burn prescriptions by meeting aquatic conservation strategy objectives.

The LRMP has monitoring requirements pertaining to soils:

- Monitoring Objective- To evaluate the effectiveness of Forest Plan standards and guidelines in the prevention of loss in soil productivity.
- Method- Field sample and measurement of soil loss, displacement, and compaction on one project area per Ranger District per year.

Analysis Methodology

Existing Condition

In addressing the effects of past wildfires on the current landscape, fire severity was derived from the burned area reflectance classification (BARC) analyses in the Burned Area Emergency Rehabilitation Reports. High-severity fire kills all or most of the vegetation (only the tops of sprouting hardwoods) and burns the crowns. Moderate-severity fire kills most or all understory vegetation, but generally does not burn the tree crowns. Low-severity fire kills only smaller understory vegetation.

Soil Effects

First Order Fire Effects (FOFEM) Model

Soil heating, percent of duff consumption and mineral soil exposure were modeled using First Order Fire Effects Model (FOFEM) version 5. FOFEM is recognized by the U.S. Forest Service as being the most current and accurate analysis tool available for first order fire effects to soil (Reinhardt et al. 1997). It is based on extensive research in western forest ecosystems. Because the model is static, adjustments were made to reflect the mosaic patterns of prescribed fire compared to the less random burn patterns of wildfire occurrence.

Inputs to FOFEM created outputs to estimate soil heating, duff consumption and mineral soil exposure under two moisture regimes; a hot, dry condition to simulate a wildfire event and a cooler, moderately dry condition to simulate prescribed fire effects. Prescribed fire fuel moisture conditions were assumed to be between dry and moderate (i.e. 13% 10 hr.; 23% 1000 hr. and 58% duff) for middle to upper slope positions and moderate for lower slope positions (i.e. 16% 10 hr.; 30% 1000 hr. and 75% duff).

Both moisture regimes were applied to two vegetation types, Sierra Mixed Conifer (SAF 243) and Interior Douglas-Fir (SAF 210) (Eyre 1980). The values for each moisture regime were averaged between the two vegetation types for effects analysis.

Output from First Order Fire Effects Model (FOFEM) was combined with vegetation data and modeled fire intensity to predict fire severity, duff consumption and exposed soil as a result of the proposed treatments. For prescribed fire modeling, the outputs for duff consumption and mineral soil exposure were reduced by 25% for the purposes of reflecting the mosaic nature of prescribed fire. For the wildfire scenario outputs, duff consumption and mineral soil exposure were not adjusted. Soil heating data were not further modified, but similar mosaic effects can be expected similar to other values measured by FOFEM.

One major assumption FOFEM makes in predicting fuel consumption is that the entire treatment area burns. FOFEM does not predict fire effects for patchy or discontinuous burns, thus overestimating the groundcover consumption. In addition, modeling assumed that all "forested" vegetation types have equivalent fuel conditions (i.e. fuel loading, fuel moisture, etc.) throughout the landscape and did not incorporate areas such as meadows, shrubfields, etc. To show a more accurate depiction of values, the FOFEM outputs were modified by 47.5 percent based on scientific findings (Raybould and Roberts 1983).

ArcFuels and FlamMap

Because of the need to spatially predict the location of fire severity, an independent analysis of fire severity was conducted for this report. Some of the predictions from this spatially explicit modeling differ from the predictions in the vegetation and fuels reports for this project which are not spatially explicit.

ArcFuels (Vaillant et al. 2013) is an ArcGIS interface that links fire behavior models and spatial analysis for fuel treatment planning. For this analysis, ArcFuels linked fire behavior modeling (FlamMap, Finney 2006) with fuels and vegetation data, Microsoft Access and ArcGIS to predict the spatial distribution of fire severity as modeled by FOFEM (see above). This modeling process is referred to in the following sections as the fire model.

Though most of the prescribed burn areas under the action alternatives could be expected to burn at low severity, localized areas of higher severity may occur, and the model predicts these locations. Definitions of severity classes used by the fire model are not the same as those used in the BARC analysis. Anticipated increase in landslide sediment production associated with prescribed fire was determined by overlaying the high/moderate-severity burn areas predicted by the fire model with mapped geomorphically unstable areas. A landslide multiplier (Cannon et al. 2010) was then applied to these areas of overlap to account for the predicted fire effects. From the fire model, less than 10% of the area would be predicted to burn at high/moderate severity, and as a result the risk ratio of mass wasting existing sediment delivery changed very little (see table 4 below) relative to the values expected under no action.

Cumulative Watershed Effects

USLE, GEO and ERA Models

Initially a cumulative watershed effects (CWE) analysis was performed using three quantitative models: (1) USLE – surface erosion sediment model, (2) GEO – mass-wasting sediment model, and (3) Equivalent Roaded Acre (ERA) – disturbance index model (Elder 2008). The GEO and USLE (surface erosion) models were performed at the 7th field drainage level. The ERA cumulative watershed effects (CWE) analysis was performed at 4 scales of hydrologic units associated with the project area: watershed (HUC5), sub-watershed (HUC6), drainage (HUC7) and subdrainage (HUC8). Figures 4 and 5 (on pages 28 and 34 below, respectively) map the CWE results by action alternative. The GEO mass-wasting and surface erosion models are spatially explicit, while the ERA model is a spreadsheet (not spatially explicit) that serves as a disturbance index.

These models seek to define the extent to which watershed disturbances affect water quality, erosion, and delivery of sediment to the stream network. For the GEO and USLE models, existing levels are shown as 'percent over background', which is a measure of accelerated sedimentation. For the ERA/TOC model, existing disturbance levels are expressed as "equivalent roaded acres" (ERA). Inference point values for each model have been identified at the following levels: (1) USLE (surface erosion) model = 400% over background, (2) GEO (mass-wasting) model = 200% over background, and (3) ERA/TOC model = watersheds TOC value.[1]

Recovery periods vary for the three CWE models. Surface erosion (USLE) generally recovers within 6 to 10 years. The GEO model assumes no recovery through the first 10 years following disturbance and the ERA model a 30 year recovery. The recovery depends on reestablishment of subsurface hill slope hydrology and root strength. The ERA disturbance model uses disturbance coefficients and recovery curves developed by the Shasta-Trinity National Forest. Recovery occurs more rapidly with prescribed fire due to lower levels of disturbance and more slowly for disturbances that result in soil displacement and compaction. Disturbance data for existing and reasonably foreseeable actions used in the analysis were provided by the Shasta-Trinity National Forest (contained in project record).

The CWE ERA analysis was updated in 2018 to include:

- additional areas that burned in 2015 & 2017;
- updates from the USFS FACTS database through November 2017, that tracks vegetative treatments on lands managed by the Forest Service;
- private timber harvest activities through 2017 from Cal-fire;
- active private lands vegetation management activities from Cal-fire that are presently occurring including emergency exemptions and 1-3 acre conversions;
- estimations of disturbance from illegal cannabis grow sites on public lands;
- and other USFS activities that are planned on public lands.

Fire Severity and Cumulative Watershed Effects

The outputs derived from the FOFEM and FlamMap models were used to predict cumulative effects of the action alternatives. The CWE models (USLE, GEO and ERA) assume that the effects of high- and moderate-severity fire are very similar in respect to landslide potential, and that they are equivalent to those of regeneration timber harvest, since most of the vegetation is killed. Low-severity fire is assumed to have no effect on landslide potential because it consumes only smaller understory vegetation and has a negligible effect on root support and slope hydrology.

[1] The inference point values cited above have been used provisionally on the Shasta Trinity National Forest since the late 1980s. They played a large role in determining CWE associated with Forest Plan (Areas with Watershed Concerns) shown in the Record of Decision for the Final Environmental Impact Statement [Land and Resource Management Plan].

Existing Condition

The existing condition is influenced by the historic wildfire and other past actions. Table 1. Past, current/ongoing and reasonably foreseeable future actions and events.

Activity	Description	Date(s)	Location	Scope
Miscellaneous fires	Wildfires	1910-1980	In and adjacent to the project area	38,120 acres within wilderness, 768 acres within project area
1987 Complex	Wildfires	1987	Throughout the wilderness but outside the project area	35,252 acres within wilderness
Megram	Wildfire	1999	Mostly within but also adjacent to project area	70,351 acres within wilderness, 49,008 within project area
Bar Complex	Wildfire	2006	In and adjacent to project area	94,596 acres within wilderness, 7,460 within project area
Iron Alps Complex	Wildfire	2008	Portions within project area, portions outside project area but within wilderness	30,548 acres within wilderness, 3,708 acres within project area
Backbone (including Redspot and Trinity Fires)	Wildfire	2009	Mostly within but also adjacent to project area	5,162 acres within wilderness, 4,501 acres within project area
Corral Complex	Wildfire	2013	Mostly outside the project area, portions adjacent to or within the project area	Approximately 800 acres within the project area, 125 acres within proposed treatment units
River Complex	Wildfire	2015	Mostly outside the project area, portions adjacent to or within the project area	725 acres within proposed treatment units
Trail Maintenance	Trail maintenance activities per (FSM 2323.13f)	Throughout the Past	Throughout the wilderness, including within and outside the project area	Approximately 71 miles of trail within the project area, of which 55 miles have been maintained within the last 5-10 years.
Wildfire suppression	Suppression of naturally occurring wildfires	Throughout the Past	Throughout the wilderness, within and outside the project area	Fires have occurred on ~65,000 acres within the project area since 1910 (including acres re-burned), with varying levels of active suppression.
Trinity Reforestation	Site preparation: Hand piling and burning / chipping & masticating	Beginning 2017	Thoughout areas burned in 2015 wildfires	Quinby Creek, Barron Creek & Caraway Creek (364 acres of piling and burning & 247 acres of mastication/chipping)
Trinity Post Fire Hazrd Reduction and Salvage	Hazard tree removal along roads,	Beginning in 2018	Thoughout areas burned in 2015 wildfires	Quinby Creek, Barron Creek & Caraway Creek (85 acres of mechanical thinning, 492 acres of mastication , piling & burning

Soil

Soils are biodynamic bodies of mineral matter, organic materials, micro-fauna, vegetation, and air. The combination of these components makes up the soil ecosystem. The soil ecosystem consists of above- and below-ground components. The above-ground component is the forest floor that consists of coarse woody debris, organic matter, litter, and duff mat. The below-ground component is mineral soil that consists of mineral materials, organic matter, and pore space. Biological activities occur in the forest floor and within the soil. Disturbances, both natural and anthropogenic, may impact both the above- and below-ground components. Prescribed management activities must consider impacts to both above- and below-ground components.

Soil mapping for the majority of the project area was performed at Fifth Order (USDA Forest Service 1994).[2] The soil polygons are larger than a Third Order survey; consequently, the soil mapping is more generalized. As displayed in Figure 3 below, soils in the project area are predominantly mapped as metasedimentary. Smaller units are mapped as granitic or serpentine. Within the metasedimentary unit, pockets of granitic, limestone and serpentine soils exist. Soil textures vary but are predominantly skeletal loams. Generally the soils range from shallow to moderately deep. All soils are mapped as either Entisols or Inceptisols, indicating little soil profile development and low to moderate productivity.

Erosion hazard is a relative measure of soil sensitivity to erosion processes. Soil disturbance has the potential to increase the erosion hazard because soil cover is generally reduced. Most of the proposed treatment areas have been previously disturbed by wildfire. Calculated maximum erosion hazard ratings (EHR), which rate soil erodibility for 100% bare soil, are predominantly moderate to high. Soils with very high EHR exist in the western third of Quinby Creek Drainage.

The project area is steep, rugged terrain. Less than 10% of the area is gently sloped (see table 1 below). Susceptibility to erosion and sediment delivery to the stream network increase with increasing slope. Particularly on steep slopes, ground cover is critical to keeping soil in place and preventing it from reaching the stream network.

Table 2. Percentage of 7th field watershed drainages in analysis area by percent slope category.

Drainage (HUC 7)	0-10%	10-35%	35-65%	>65%
Eightmile Creek	11.3	39.7	24.7	24.4
Sixmile Creek-Virgin Creek	10.3	37.2	23.9	28.6
Twomile Creek-Virgin Creek	7.1	34.7	25.0	33.2
North Fork Eagle Creek	10.9	39.2	23.2	26.7
Eagle Creek-Slide Creek	10.0	37.7	22.5	29.8
Lower Slide Creek	6.8	34.3	25.4	33.5
Quinby Creek	7.7	31.0	24.7	36.7
Barron Creek-Caraway Creek	6.2	30.2	25.7	37.9

[2] See Appendix A Glossary.

Drainage (HUC 7)	0-10%	10-35%	35-65%	>65%
Percentage of project area in each slope percent category	8.9	35.4	24.2	31.4

Historic repeated wildfire within the project area increased soil erosion, and reduced soil productivity. Hydrophobic soils were documented in the project area as a result of the high-severity wildfires that occurred in 2008 and 2009; however these conditions are expected to have recovered since that time. In 2013, approximately 800 additional acres burned in the Corral Fire that overlapped into the Trinity Alps Prescribed Fire project area and again in 2015 the River Complex burned an additional 725 acres. Overall, the soil burn severity within the project area was of low to moderate severity and low to moderate intensity and did not result in any significant concerns to soil and water resources.

Geology

Bedrock and Structure

The project area lies within the Klamath Mountains Geologic Province, which is composed primarily of metamorphic rock, along with granitic plutons, such as the Ironside Mountain Pluton, which lies along the western margin of the project area. It is part of Irwin's Western Paleozoic and Triassic subprovince and consists entirely of accreted terranes, including the Sawyers Bar and Western Hayfork terranes (Irwin 1966). The Sawyers Bar terrane includes the Salmon River and Eastern Hayfork units. The Eastern Hayfork unit comprises the bulk of the project area and contains mostly metasedimentary rock (chert, argillite and volcaniclastic rock), along with some peridotite. Though not identified in the Forest GIS coverage, marble is known to exist in small bodies in this unit in the western part of the project area. The Salmon River unit includes gabbro, diabase, peridotite/serpentinite, and metavolcanic rock. The Western Hayfork terrane includes both metavolcanic and metasedimentary rock.

The Klamath Mountains have been subjected to long periods of uplift, which continue to the present time. The uplift process – along with the presence of weak rock units typical of accreted terranes, a wet climate, and seismicity-associated coastal earthquakes – has created a steep rugged landscape sculpted in large part by landsliding, primarily in the form of debris slides. Large, deep-seated landslides are uncommon relative to adjacent watersheds. The westernmost part of the project area, which is underlain by diorite, is subject to shallow debris slides due to the presence of the sandy soil that develops on granitic rock. The headwaters of some of the drainages, such as Eightmile Creek, were substantially sculpted by glaciers during the Pleistocene Era, resulting in glacially scoured basins and moraine deposits. Only a few of these are currently mapped and identified in GIS.

Sensitive areas (i.e. areas prone to landslides) include seeps adjacent to draws and inner gorges. Drainages with a large number of recent debris flow tracks include Eagle, Slide, Eightmile, Twomile, and Virgin Creeks. Steep eroding headwalls, active and dormant debris slides, and inner gorges occur throughout the project area. Large recent wildfires, such as the Backbone, Bake Oven, and Megram fires removed a large proportion of the vegetation and increased the potential for landslides.

Examination of 1982 aerial photos indicates that the 1964 flood played an important role in channel alteration processes. Large debris slides (shallow rapid landslides) are visible in the headwaters of Eightmile (Section 17), Virgin, Eagle, and Slide Creeks. These landslides initiated debris flows and scoured long segments of the channels. The degree of re-vegetation apparent on the 1982 aerial photos indicates that the landslides probably occurred around 1964. The largest is in Eightmile Creek, and it remains clearly visible on 2008 imagery. In the course of examining these aerial photos, it became apparent that many of the "active" debris slides identified in the GIS layer are much older features, may be hundreds or even thousands of years old, and might be more aptly mapped as "headwall basins". These are less sensitive features, and as such, the present analysis can be considered the greatest predicted impacts.

Watershed/Hydrology

The project area and its drainages are within the New River 5th field Watershed. The New River Watershed, a tributary to the Trinity River, is a Tier 1 "key" Watershed (designated in the LRMP) that provides refugia for maintaining and recovering habitat for at-risk stocks of anadromous salmonids and resident fish species. There are eight 7th field drainages within the New River Watershed as shown in table 2 below. Streams within the project area exhibit relatively steep gradient and are primarily sediment transport reaches. Riparian reserves are designated along stream channels, surface waterbodies and wetlands. They are to be managed to provide benefits to riparian dependent species.

The Trinity River is listed as sediment impaired by the Environmental Protection Agency (EPA) under the Clean Water Act section 303d. A total maximum daily load assessment (TMDL) has been completed (US Environmental Protection Agency (EPA) 2001. New River, North Fork and East Fork North Fork are all considered as reference watersheds in the TMDL which means there is no proposed sediment reduction needed within these areas to comply with the TMDLs. A road focused sediment source analysis that provides option for reducing and mitigating impacts with the New River Watershed is complete (NRM 2012).

Table 3. Project area drainages (HUC7). [3]

Drainages (HUC7)	Acres
Eightmile Creek	6,954
North Fork Eagle Creek	7,696
Sixmile Creek-Virgin Creek	9,514
Eagle Creek-Slide Creek	10,056
Lower Slide Creek	8,254
Twomile Creek-Virgin Creek	7502
Barron Creek-Caraway Creek	5,401
Quinby Creek	2,975

The New River Watershed and its associated drainages within the project area are identified as reference (healthy) watersheds within the Trinity TMDL for sediment. Reference watersheds are defined as watersheds that are currently exhibiting high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition and exhibit a stable drainage network. Physical and biological conditions suggest that aquatic and riparian systems are predominantly functional in terms of supporting dependent species and beneficial uses of water. Management-induced disturbances have not resulted in significant alteration of geomorphic, hydrologic or biotic processes, nor have concerns for such effects been raised to date.

[3] Drainage maps are available to review in effects sections by alternative.

The Trinity River has historically been recognized as a major producer of Chinook and coho salmon and steelhead trout. The New River Watershed is considered to be one of the most productive steel head fisheries in the state of California (USDA Forest Service 2000). Existing downstream beneficial uses for the New River are listed as municipal and domestic supply, agricultural supply, industrial service supply, industrial process supply, groundwater recharge, freshwater replenishment, navigation, hydropower generation, water contact recreation, non-contact water recreation, commercial and sport fishing, cold freshwater habitat, wildlife habitat, rare threatened or endangered species, migration of aquatic organisms, spawning, reproduction, and/or early development.

Existing Disturbances

The primary disturbance to soil and water resources within the project area is from relatively recent wildfire and fire suppression efforts, recreation and mining.

The drainages encompassing the project area are largely unroaded because the headwaters are within a designated wilderness area which does not allow road construction. The lowermost portions of the drainages are the only areas with roads.

Hiking and recreation stock trails exist shown on Figure 1, which have localized impacts to soil and water resources; the stream crossings associated with these trails have a much greater potential for erosion and sediment transport that migrates through the stream system. A review of existing stream crossings in the area (Figure 1) found that there are approximately 80 stream crossings associated with the trails within proposed treatment areas and dozens more surrounding the treatment area. These locations are points where streams are most susceptible to degradation. Trail stream crossings in the wilderness are primitive improvements stabilized by local native rock with small fills if any at all. During large storm events these areas are susceptible to erosion transport and even stream diversion down the trails and loss of the fills.

There are roughly 90 historic mines within the treatment areas as well concentrated primarily on the eastern edge of the project area below Mary Blaine Mountain and Dees Peak, in the headwaters of Battle Creek that drains into Eagle Creek and Emigrant Creek that drains into Slide Creeks. While many of these areas likely have remnant signs of mining disturbance, most sites would be undetectable due to the recovery associated with the passage of time and the limited size of the operations in such a remote location.

While this area was grazed in the past it has not been actively grazed by domestic livestock for years. Impacts from hunting and historic grazing are limited in extent.

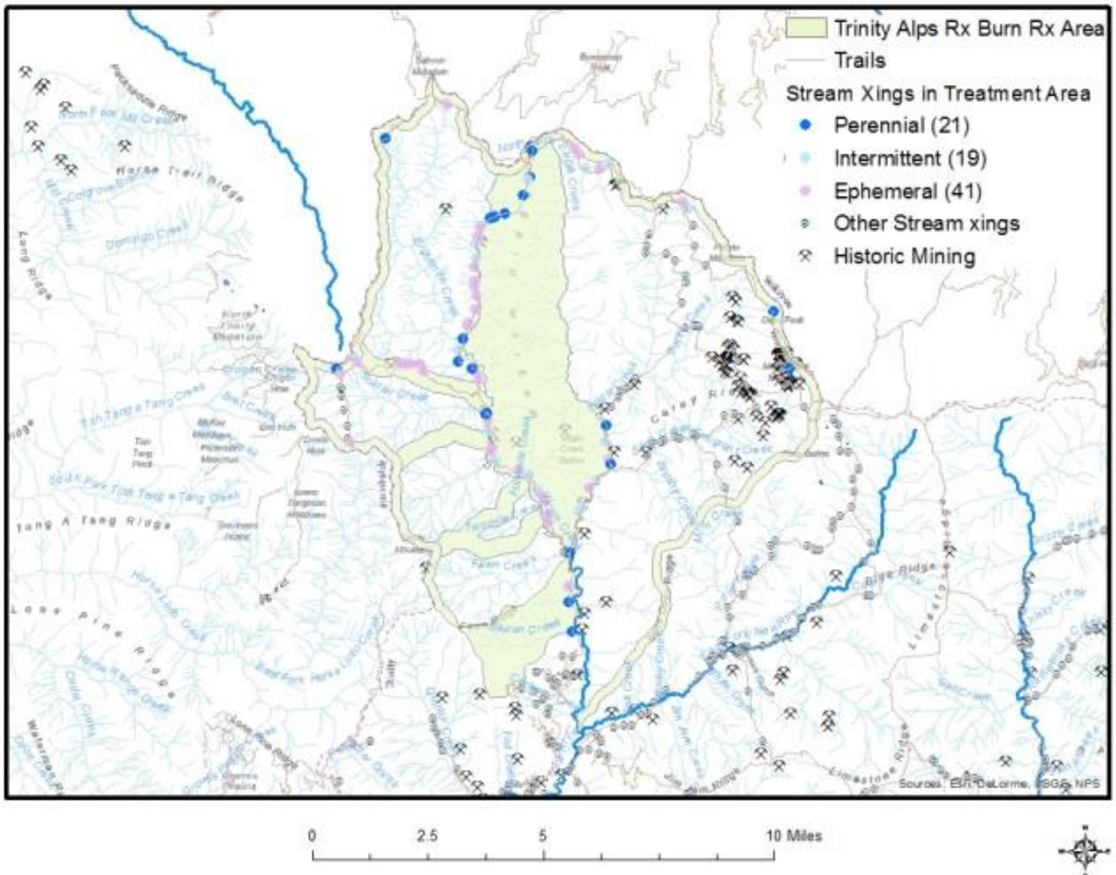

Figure 1. Existing disturbance, Trails, Stream Crossings and Historic Mining

Both lightning- and human-caused wildfire ignitions may occur. Wildfire is a natural process within the project area; however, fire suppression has likely contributed to a shift to higher fire severity in wildfires over the last decades. Current fuel conditions in the project area increase the risk of future intense fire behavior and adverse effects to resources. Repeated wildfire, particularly with large areas of moderate and high severity, has increased the risk of landsliding and debris flows, soil erosion (loss of soil productivity), and transport of increased sediment to surface waters. See the project Fire, Fuels, Air Quality and Vegetation Report for more detailed information on the history of wildfire in the project area.

USLE (Modified Universal Soil Loss Equation) Model

This model predicts sediment delivery to streams from surface erosion based on a modified USLE equation, as described by Elder (2008). The risk ratio is the percent of predicted sediment over background values. An inference point of 400% over background is assumed (Elder 2008). Recovery from surface erosion is based on vegetation cover, and a faster recovery is assumed than in the geologic and ERA (disturbance) models. As displayed in table 3 below, Eightmile Creek and Sixmile Creek-Virgin Creek show the greatest potential for increased sediment delivery due to recent large fires with relatively high severity.

Table 4. USLE-based surface erosion sediment delivery potential – existing condition.

Drainages (HUC7)	Background*	Existing*	Risk Ratio	Acres	Road Miles
Eightmile Creek	224	353	0.14	6,966	0.1
Sixmile Creek-Virgin Creek	253	394	0.14	9,525	0.0
Twomile Creek-Virgin Creek	193	200	0.01	7,506	0.0
North Fork Eagle Creek	141	141	0.00	7,696	0.0
Eagle Creek-Slide Creek	197	206	0.01	10,056	0.2
Lower Slide Creek	164	185	0.03	8,254	0.0
Quinby Creek	420	431	0.01	5,629	11.4
Barron Creek-Caraway Creek	453	498	0.02	10,596	44.3

*Delivered sediment (yds^3/year).

GEO Model

This model estimates sediment delivery to streams from mass wasting; the model has its empirical base in the Salmon Sub-basin Sediment Analysis (de la Fuente and Haessig 1994) and uses methodology developed in Amaranthus et al. (1985), the Grider EIS (USDA Forest Service 1989) and Klamath National Forest LRMP (USDA Forest Service 1995b). The Salmon sub-basin is immediately to the north of the watershed divide between the Klamath and Trinity River Systems, and geology is very similar; as a result, the landslide coefficients should reasonably predict landslide sediment production in the project area. Predicted sediment delivery is for the first decade following project completion. Coefficients recover to background values in 50 years with no recovery in the first 10 years. For the GEO (mass wasting) model, coefficients predict sedimentation volumes from landsliding for a flood event with a recurrence interval of 10–20 years. In other words, the probability of attaining sedimentation rates of the magnitude predicted by the coefficients is 1 to 10 through 1 to 20 [i.e., 10% to 5% in any given year].

CWE model values are expressed as “risk ratios.” These ratios are calculated by dividing accelerated sedimentation by an “inference point” value. In the GEO model, accelerated sedimentation is figured as “% over background,” which is calculated from ‘current’ model-estimated sediment delivery [‘Current’ and ‘Current + proposed + future’ columns] less background [‘Background’ column] divided by background values. The inference point used is 2.0 or 200% over background.

As table 4 below shows, Eightmile Creek, Sixmile Creek-Virgin Creek, North Fork Eagle Creek, and Quinby Creek all have predicted high sediment delivery risks. All of these drainages experienced large, relatively high-severity fires in the last decade. The model assumes no recovery for the first ten years based on the assumption that stabilizing vegetation experienced a high percentage of mortality. In this scenario, the loss of stabilizing vegetation is likely overestimated and reflects high values. Nonetheless, this analysis indicates the vulnerability of these drainages to mass wasting as a result of disturbance from high-severity wildfire.

Table 5. Geologic based – Mass wasting existing sediment delivery risk.

Drainages (HUC7)	Background*	Existing*	Risk Ratio	Acres	Road Miles
Eightmile Creek	29,335	86,152	0.97	6,966	0.1
Sixmile Creek-Virgin Creek	31,176	102,344	1.14	9,525	0.0
Twomile Creek-Virgin Creek	40,063	92,304	0.65	7,506	0.0
North Fork Eagle Creek	10,566	42,256	1.50	7,696	0.0
Eagle Creek-Slide Creek	61,132	150,755	0.73	10,056	0.2
Lower Slide Creek	29,329	51,412	0.38	8,254	0.0
Quinby Creek	12,310	44,799	1.32	5,629	11.4
Barron Creek-Caraway Creek	15,546	32,935	0.56	10,596	44.3

*Delivered sediment (cubic yards/10-year).

ERA (Equivalent Roaded Acres) Model

The ERA model tracks disturbances that affect watershed processes and provides an indicator of watershed condition. The model compares the current and proposed level of disturbance within four watershed scales as additive ERA coefficients, with a theoretical maximum disturbance level (TOC for HUC5 and HUC6 watersheds) developed by the Shasta-Trinity National Forest. These TOCs – or thresholds of concern – range from 12% to 18% and are based on watershed sensitivity. Watershed sensitivity is calculated based on the following: soil erodibility, slope, mass wasting potential and 25-year peak flow within 5-6th field watersheds (Haskins 1983).

Tables 5(a-d) below display the results of the ERA model analysis. The results indicate that the New River Watershed (HUC5) is below the threshold of concern for cumulative watershed effects with a low disturbance level (see table 5a below). Analysis of the 6th field Subwatersheds (HUC6) indicates that all hydrologic units are also below the threshold of concern (see table 5b below).

Analysis of the 7th field drainages (HUC7) indicates low levels as well even though most project would trigger an increase, this is considered to be a very low disturbance footprint. Eightmile Creek and North Fork Eagle Creek drainages have the highest risk ratios of 0.56 and 0.51, respectively. With the exception of Quinby Creek and Barron Creek-Caraway Creek, the drainages are roadless and nearly all disturbance results from wildfire. Refer to table 5c below.

Analysis of the 8th field subdrainages (HUC8) indicates that disturbance levels range from low to high. A total of 49 subdrainages were analyzed with the ERA model. Two subdrainages scored high disturbance levels, twelve scored moderate disturbances levels, and the remaining thirty-seven indicated low disturbance levels. Wildfires in the past few decades resulted in the moderate and high disturbance levels in the subdrainages (HUC8) listed in table 5d below.

Table 6a. 5th field watershed ERA model -existing condition (2018).

Watershed (HUC5)	TOC	ERA	% ERA	Risk Ratio	Disturbance Level	Acres
New River	14%	1765.4	1.2%	0.08	LOW	14,9364

Table 6b. 6th field watershed ERA model -existing condition (2018).

Watershed (HUC5)	Sub-watershed (HUC6)	TOC	ERA	% ERA	Risk Ratio	Disturbance Level	Acres
New River	Eagle Creek	16%	123.9	0.5%	0.03	LOW	21,629
	Sixmile Creek	14%	59.2	.2%	0.02	LOW	23,998
	Upper New River	14%	411.4	1.9%	0.14	LOW	21,396

Table 6c. 7th field watershed ERA model -existing condition (2018).

Sub-watershed (HUC6)	Drainage (HUC7)	ERA	% ERA	Risk Ratio	Disturbance Level	Acres	Road Miles
Upper New River	Barron Creek-Caraway Creek	246.9	2.3%	0.17	LOW	10,596	0.1
	Quinby Creek	81.3	1.4%	0..10	LOW	5,629	0.0
Eagle Creek	Eagle Creek-Slide Creek	3.7	0.04%	0.04	LOW	10,057	0.0
	Lower Slide Creek	57.6	0.70%	0.05	LOW	8,254	0.0
	North Fork Eagle Creek	0.6	0.01%	0.00	LOW	7,696	0.2
Sixmile Creek	Eightmile Creek	2.8	0.04%	0.00	LOW	6,967	0.0
	Sixmile Creek-Virgin Creek	31.1	0.33%	0.02	LOW	9,525	11.4
	Twomile Creek-Virgin Creek	29.4	0.39%	0.03	LOW	7,506	44.3

Table 6d. 8th field watershed ERA model -existing condition (2018).

Drainage (HUC7)	Sub-drainage (HUC8)	ERA	% ERA	Risk Ratio	Disturbance Level	Acres
Eightmile Creek	1801021110010101	23.1	1.2%	0.09	LOW	1,895
	1801021110010102	4.4	0.2%	0.02	LOW	2,072
	1801021110010103	8.3	0.6%	0.04	LOW	1,494
	1801021110010104	0.5	0.0%	0.00	LOW	1,507
Sixmile Creek-Virgin Creek	1801021110010201	4.7	0.3%	0.02	LOW	1,634
	1801021110010202	2.9	0.2%	0.01	LOW	1,551
	1801021110010203	36.5	1.9%	0.13	LOW	1,962
	1801021110010204	12.9	0.7%	0.05	LOW	1,832
	1801021110010205	8.0	0.3%	0.02	LOW	2,546
Twomile Creek-Virgin Creek	1801021110010301	1.7	0.1%	0.00	LOW	2,401
	1801021110010302	22.7	0.9%	0.06	LOW	2,506
	1801021110010303	8.1	0.3%	0.02	LOW	2,599
North Fork Eagle Creek	1801021110020101	4.5	0.2%	0.01	LOW	2,343
	1801021110020102	0.0	0.0%	0.00	LOW	1,897
	1801021110020103	0.0	0.0%	0.00	LOW	1,981
	1801021110020104	0.3	0.0%	0.00	LOW	1,476
Eagle Creek-Slide Creek	1801021110020201	6.0	0.3%	0.02	LOW	2,337
	1801021110020202	4.8	0.2%	0.02	LOW	2,188
	1801021110020203	7.5	0.3%	0.02	LOW	2,278
	1801021110020204	4.6	0.4%	0.03	LOW	1,253
	1801021110020205	0.0	0.0%	0.00	LOW	526
	1801021110020206	1.6	0.2%	0.02	LOW	657
	1801021110020207	2.1	0.3%	0.02	LOW	817
Lower Slide Creek	1801021110020301	23.1	0.9%	0.06	LOW	2,618

Drainage (HUC7)	Sub-drainage (HUC8)	ERA	% ERA	Risk Ratio	Disturbance Level	Acres
	1801021110020302	12.0	1.0%	0.07	LOW	1,247
	1801021110020303	20.0	0.9%	0.06	LOW	2,309
	1801021110020304	20.3	1.0%	0.07	LOW	2,080
Upper East Fork New River	1801021110030101	6.0	0.3%	0.02	LOW	2,248
	1801021110030102	6.0	0.2%	0.01	LOW	2,582
	1801021110030103	4.4	0.2%	0.01	LOW	2,075
	1801021110030104	5.8	0.2%	0.02	LOW	2,372
Milk Creek-Pony Creek	1801021110030201	0.8	0.1%	0.00	LOW	2,794
	1801021110030202	0.2	0.0%	0.00	LOW	2,652
Middle East Fork New River	1801021110030301	5.4	0%	1%	LOW	1,464
	1801021110030302	45.3	2%	11%	LOW	1,785
	1801021110030303	0.0	0.0	0.00	LOW	1,286
	1801021110030304	0.0	0.0	0.00	LOW	1,486
Lower East Fork New River	1801021110030401	14.6	1%	9%	LOW	988
	1801021110030402	23.5	1%	9%	LOW	1,681
	1801021110030403	116.0	4%	25%	LOW	2,956
Quinby Creek	1801021110040101	40.1	2%	11%	LOW	2,580
	1801021110040102	20.2	2%	15%	LOW	976
	1801021110040103	21.0	1%	7%	LOW	2,074
Barron Creek-Caraway Creek	1801021110040201	20.8	1%	6%	LOW	2,529
	1801021110040202	19.8	1%	11%	LOW	1,340
	1801021110040203	53.4	4%	32%	LOW	1,196
	1801021110040204	54.7	3%	20%	LOW	1,969
	1801021110040205	61.0	4%	31%	LOW	1,421

Drainage (HUC7)	Sub-drainage (HUC8)	ERA	% ERA	Risk Ratio	Disturbance Level	Acres
	1801021110040206	37.0	2%	12%	LOW	2,133

Modeling results indicate that even though the area has burned repeatedly with small portions burning at high and moderate levels, there is enough time between these fires that the models show significant recovery. Drainages and sub-drainages are all considered to have low disturbance levels. The GEO (mass wasting) model indicates very high disturbance levels in Quinby Creek Drainage; the west portion of this drainage also has soils with very high EHR, and is therefore more sensitive to disturbance. Both the ERA and USLE models indicate low levels of disturbance in Quinby Creek because these models evaluate factors that show recovery since the last wildfire disturbance.

Table 7. Summary and validation of ERA modeling -existing condition.

Associated Sub–Watershed (HUC6)	Drainage (HUC7) of Concern	Disturbance at Drainage (HUC7) Scale			Sub-drainage (HUC8) Scale	
		GEO Model	USLE Model	ERA Model	Associated HUC8	ERA Model
Sixmile Creek	Sixmile Creek – Virgin Creek	VERY HIGH	LOW	LOW	1801021110010201 - 1801021110010205	LOW
	Eightmile Creek	HIGH	LOW	LOW	1801021110010101- 1801021110010104	LOW
Eagle Creek	North Fork Eagle Creek	VERY HIGH	LOW	LOW	1801021110020101 - 1801021110020104	LOW
	Eagle Creek – Slide Creek	MOD	LOW	LOW	1801021110020201 – 1801021110020207	LOW
Lower New River	Quinby	VERY HIGH	LOW	LOW	1801021110040101 - 1801021110040103	LOW

Desired Condition

The Desired Future Condition (DFC) of the Shasta Trinity National Forest is embodied in Forest Goals and Objectives for resources of concern found in the forest plan (USDA Forest Service 1995a) on page 4-6. The DFC is further clarified by the standards and guidelines for those resources and for designated Management Areas (MAs) such as the Trinity Alps Wilderness (MA4). Based on those goals, objectives, standards and guidelines, the following desired future conditions for geology, soils and watershed/hydrology were identified.

Soil

Shasta-Trinity National Forest soil standards and guidelines are met, thereby providing conditions to maintain long-term soil productivity based on site potential within the project area.

Geology

Management activities do not impact slope stability beyond natural background levels. Caves and associated resources are protected as required under the Cave Protection Act.

Watershed/Hydrology

High quality waters are maintained and downstream beneficial uses are protected.

Project Design Features

Hydrology

The following hydrology design features have a high probability of reducing the effects of prescribed fire and protecting water quality, soil and aquatic resources, and designated beneficial uses: These design features were developed to ensure that the project has a high probability of meeting the following Region 5 Water Quality Management for Forest System Lands in California BMPs (USDA Forest Service 2011, R5 Soil and Water Quality Handbook) and the Shasta-Trinity National Forest LRMP Standards and Guidelines.

1. Table 7 provides the minimum riparian reserve boundaries by category of streams and waterbodies (LRMP p. 4-53, 4-54).

Table 8. Minimum riparian reserve boundaries, by category.

Stream and Waterbody Category	Intermittent or Seasonally Flowing Channels	Fish-bearing Streams	Perennial Non-fish-bearing Streams	Springs	Seasonally Wet Meadows > 1 acre
Minimum Extent of Riparian Reserve Width	100 feet on either side of the channel	300 feet on either side of the channel	150 feet on either side of the channel	100 feet from the edges of riparian vegetation	150 feet from the edge of the meadow

1. Riparian reserves that encompass inner gorges would extend to cover the entire inner gorge area if it is greater than 150 feet in width.
2. Site specific riparian reserve maps will be provided prior to implementation. If dry streams show signs of annual scour, they will be treated as seasonally flowing streams.
3. Broadcast and underburn prescribed fire would not be ignited within riparian reserves. Fire would be allowed to back into riparian reserves to promote a low-intensity backing fire.
4. No new fire line would be constructed.
5. 0Existing trails and handlines used as fire lines would have erosion control structures constructed or reconstructed as needed following treatments to control surface flows and minimize off-site erosion.
6. Mulch hand lines that have less than 35 percent rock fragments with native materials such as fine slash, organic matter and duff. Existing trails used as fire lines only need water bars (no mulching).

7. Installation of water bars on hand lines on ultramafic/Serpentine soils (Figure 2) will occur when soil moisture is sufficient to reduce hazard from Naturally Occurring Asbestos (NOA) (no or minimal dust created during water bar construction).
8. Construct or reconstruct critical dips at all perennial stream crossings. Maintain 80 percent stream shade where it already exists.
9. Prescribed fire would be designed to retain large dead woody debris (> 12 inches in diameter), both standing and downed, in riparian reserves within a range to meet historical levels (prior to suppression era) according to table 8 below. Seasonally wet meadows and similar riparian features that do not support recruitment of large woody debris would not be included.
10. In order to protect spawning and incubating eggs, field personnel would not enter waterways where anadromous fish are determined to be spawning or eggs would be incubating, as determined and indicated by a fisheries biologist. Restricted time periods are generally from October 15 through June 15. Additional restrictions may be appropriate for waterways containing Spring Chinook salmon and summer-run steelhead, as determined by a fisheries biologist.
11. To minimize the potential for cumulative adverse effects when underburning, no more than ten percent of a sixth-field watershed (per fisheries design criteria) would be burned in any one year.
12. Prescribed fire would be designed to result in a mosaic of low-intensity fire and unchanged vegetation within areas with very low or low burn probabilities with no more than 50% of the area having patches of high or moderate soil burn severities (missing litter or duff) except for highly erodible soils (soils developed from granitic parent material), where ground cover should be in excess of 90% and evenly distributed (LRMP Appendix O).
13. Best Management Practices (BMPs) would be implemented during all activities. A description of each applicable BMP is included in Appendix B of the EA. Monitoring of implementation and effectiveness would follow existing protocol and direction given in the National Best Management Practices for Water Quality Management on National Forest System Lands[4] to ensure that water quality objectives are being met.

Table 9. Range of LWD by stream/waterbody category.

Stream and Waterbody Category	Intermittent or Ephemeral Channels (tons/acre)	Fish-bearing Streams (tons/acre)	Perennial Non-fish-bearing Streams (tons/acre)	Springs (tons/acre)
Range of Desired LWD Loading (>12" dia.)*	15-30	35-60	30-50	20-40

Sources: Brown et al. 2003; Knapp et al. 2005; Uzoh and Skinner 2009.

[4] USDA Forest Service 2012.

Monitoring

This project will be included in the forest wide pool of projects to be monitored for BMP effectiveness.

Geology

Prescribed Fire in the Unstable Land Component of Riparian Reserves – Active landslides and inner gorges make up the unstable land component of Riparian Reserves on the Shasta-Trinity National Forest. The Forest Geomorphology layer reveals that active landslides are common between Election Gap and Salmon Mountain along the Trinity/Klamath divide. These are primarily debris slides (shallow, rapidly moving landslides), and many appear to reach to near the ridge crest. Some appear to be associated with the 1964 flood. Since treatments are primarily confined to ridge top locations, most inner gorges within the analysis area would not be affected. However, fire would be backed down into some creeks such as Virgin Creek, New River and Slide Creeks and could reach some inner gorges in those areas. The following design features apply:

1. Prescribed fire would be kept at low severity in active landslide areas and inner gorges.

Cave and Karst Resources – There is one known marble cave near the treatment area , and other marble caves are known to exist in the Limestone Bluffs Research Natural Area on the Klamath National Forest, about 1.5 miles northeast of the project area. Though marble outcrops are not mapped within the project area (none appear on the Forest's GIS bedrock layer), such bodies are often small and some may have been missed during bedrock mapping projects. The following design features apply:

2. No burning will occur within 200 feet of all known caves and marble outcrops. Cave locations would be held confidential in accordance with the Federal Cave Resource Protection Act of 1988. Such information would be made available to appropriate implementation personnel as needed to protect cave resources from inadvertent damage during implementation.

Naturally Occurring Asbestos Hazard – Ultramafic serpentine occurs along the ridge crest from Election Gap to Salmon Mountain, with the largest outcrop (about a mile wide) near Mary Blaine Mountain, and a much smaller body (less than 0.25 mile wide) near Potato Mountain (see Figure 2 on the following page). Ultramafic rock often contains naturally occurring asbestos (NOA). NOA occurs in rocks and soil as a result of natural geological processes. Natural processes and human activities may disturb NOA-bearing rock or soil and release mineral fibers into the air, which pose a potential for human exposure by inhalation.

State, federal, and international health agencies have classified asbestos as a known cancer causing substance. It has been demonstrated that asbestos fibers can cause lung cancer and various other serious illnesses but symptoms might not appear for 15 to 40 years after exposure to asbestos. Exposure does not mean the recipient will definitely develop health problems. Factors such as type of asbestos, quantity, and duration and frequency of exposure are all important considerations. Knowing how to minimize or eliminate exposure is the best way to protect lung health and avoid possible adverse health effects. Any activity that creates dust where NOA is present has the potential to cause harm unless mitigation and precautions are taken. The following measures are effective in minimizing exposure:

- Limit dust generating activities;
- Avoid dusty areas, especially in windy conditions;
- Drive slowly over unpaved roads, and keep windows and vents closed when in route to the project area;
- Spread out crews on trails and avoid generating dust clouds.

The following design features apply:

1. A map of all known ultramafic rock and soils (Figure 2) would be provided to field personnel prior to project implementation to inform employees of the work areas having associated health risks that require special protection measures to provide employee safety. This map would be at a scale of 1:24,000 or larger or other appropriate electronic format (e.g. files for global positioning systems – GPS) and show roads, trails and existing firelines overlain on ultramafic rock.
2. Fire line maintenance in areas underlain by ultramafic rock or soil (Figure 2) would be conducted during moist soil conditions to minimize dust generation.
3. A project-specific Job Hazard Analysis will include effective and feasible dust abatement measures tailored to the project area, such as deferment of trail erosion control, until site conditions are moist and use of approved respirator equipment as appropriate.

Monitoring

This project will be included in the forest wide pool of projects to be monitored for geological hazard implementation effectiveness.

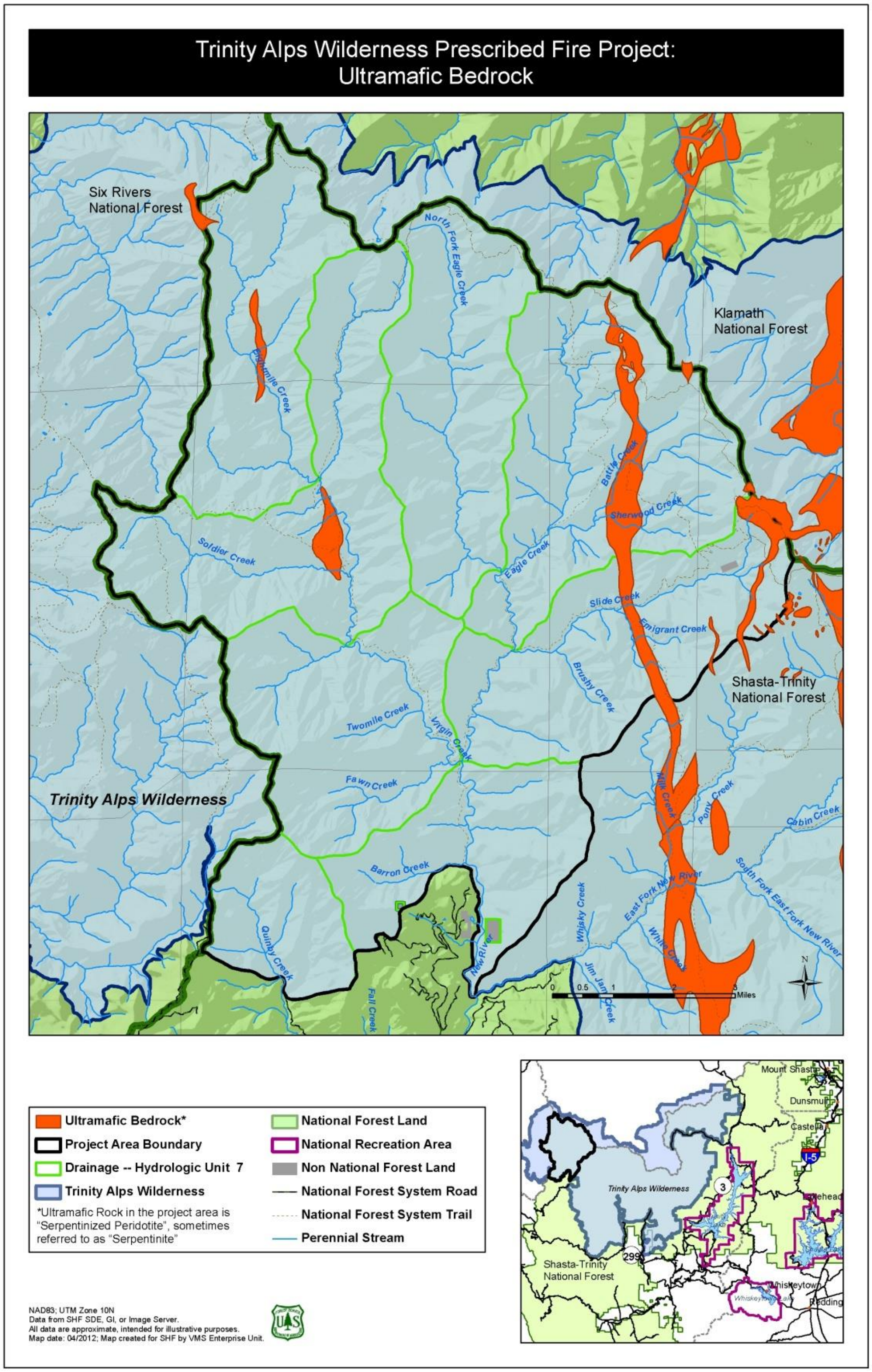

Figure 2. Occurrences of ultramafic rock, which may contain naturally occurring asbestos, in the project area.

Soils

The following soil resource design features have a high probability of reducing the effects of prescribed fire on soil productivity and maintaining the functionality of the soil resource. These design features were developed to ensure that the project has a high probability of meeting Best Management Practices (BMPs)(USDA Forest Service 2012 soil management direction USDA Forest Service 2012) and Shasta-Trinity National Forest LRMP Standards and Guidelines (USDA Forest Service 1995a).

1. Post-treatment total soil cover should be between 50 and 70 percent on metamorphics, with at least 50 percent cover as fine organic matter (duff, plant leaves/needles, fine slash [less than 3-inch material], etc.).

2. On granitics, soil cover should be greater than 90 percent, with at least 50 percent cover as fine organic matter (duff, plant leaves/needles, fine slash [less than 3-inch material], etc.). See figure 2 below.

3. Retain existing down coarse woody debris (CWD) whenever possible, At least 5 logs per acre should be retained, with 4 to 8 tons/acre of fuel remaining for protection of soil fertility. Desired logs are at least 20 inches in diameter and 10 feet long.

4. Retain at least 50 percent duff and litter cover over the treatment area. If the soil and potential natural plant community are not capable of producing cover over 50 percent of the area, adjust minimum amounts to reflect potential soil and vegetation capacity.

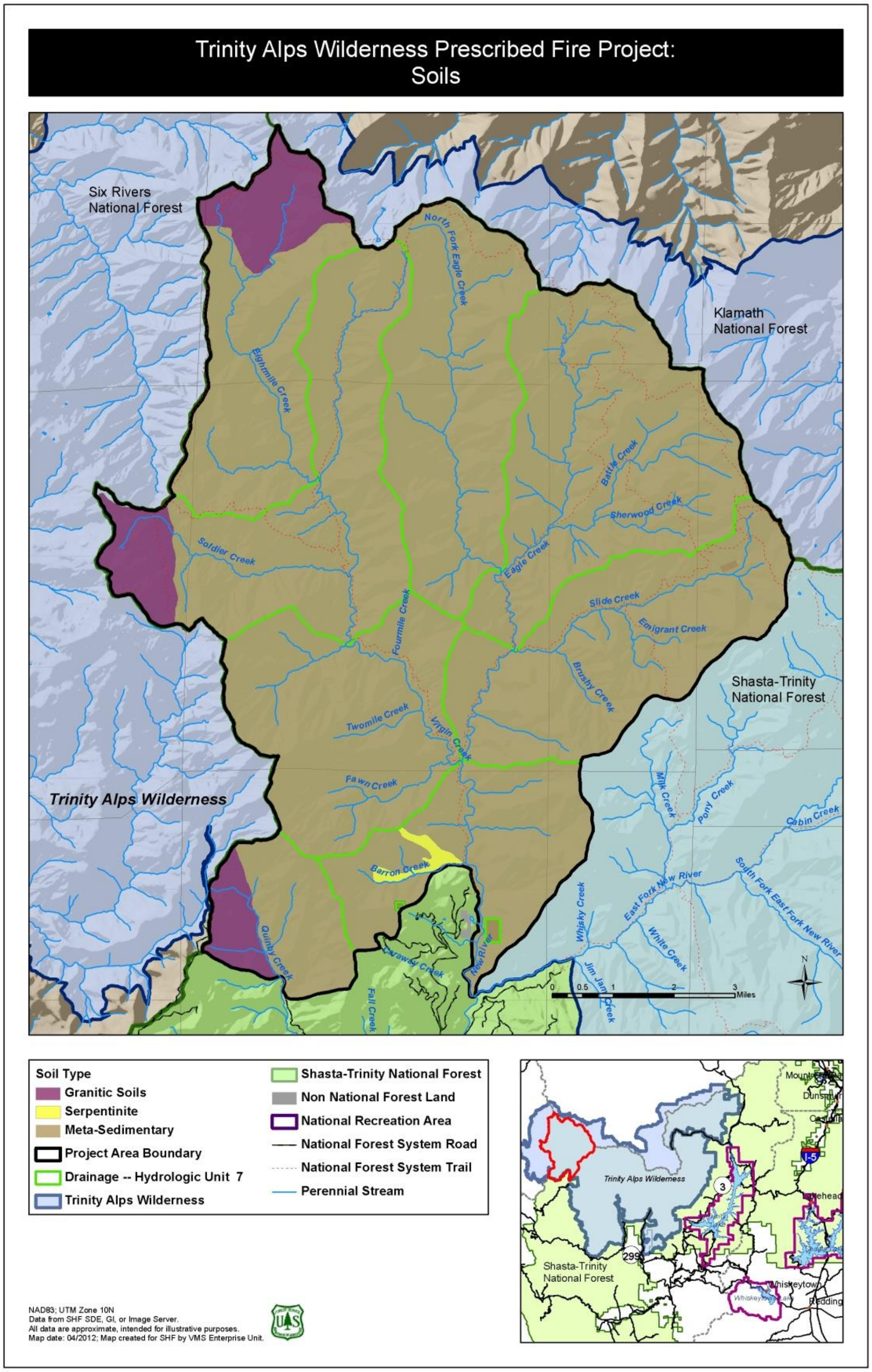

Figure 3. Soil types in the project area.

Environmental Consequences

Alternative 1 – No Action

Under the no action alternative, no fuels treatments would occur in the project area. Current fuel conditions would not be addressed. The project fuels specialist concluded that, under this alternative, fuels would be expected to continue to accumulate and contribute to increased fire behavior, intensity and severity of effects of future wildfires.

Direct Effects

Soil

The "no action" alternative would have no direct effects on soils within the project area.

Geology

The "no action" alternative would have no direct effects on geologic features within the project area.

Watershed/Hydrology

The "no action" alternative would have no direct effects on watershed/hydrologic function within the project area.

Indirect Effects

Soil

Indirectly, the "no action" alternative would allow developing litter layers to mature. Trees would continue to contribute woody debris to the forest floor, allowing decomposition to continue and adding needed organics and soil wood to the soil profile but also increasing fuels.

Wildfire is a natural and cyclic component of the project area's ecosystem. Large wildfires of moderate to high severity have occurred repeatedly over the last two decades throughout the project area and adjacent areas. As a consequence of these wildfires, associated suppression efforts and, to some extent, long-term fire suppression in the project area, current fuel conditions present a high risk of future large, high-severity wildfires. In the absence of fuels treatment, the risk of future large fires would continue to increase as additional fuels accumulate and understory vegetation develops, thus increasing surface and ladder fuels that contribute to fire spread and increase the risk of crown fire.

The no action alternative would indirectly result in a higher risk of a high-intensity wildfire. The occurrence of a high-intensity wildfire would increase the potential for impacts to soils and soil productivity in severely burned areas, especially since the risk of soil erosion increases proportionally with fire intensity (Berg and Azuma 2010, Neary et al. 1999). Loss of soil cover would significantly increase erosion thereby reducing soil productivity and increasing risk of water quality degradation from sediment. Other potential detrimental effects could include the potential loss of organics, loss of nutrients, and a reduction of water infiltration. Burns that create very high soil-surface temperatures, particularly when soil moisture content is low, result in an almost complete loss of soil microbial populations, woody debris, and the protective duff and litter layer over mineral soil (Hungerford et al. 1991, Neary et al. 2005). Nutrients stored in the organic layer (such as potassium and nitrogen) can also be lost or reduced through volatilization and as fly ash (DeBano 1991, Amaranthus et al. 1989).

Fire-induced soil hydrophobicity is presumed to be an important factor of the observed post-fire increases in runoff and erosion from forested watersheds (Huffman et al. 2001). Though hydrophobicity is a naturally-occurring phenomenon that can be found on the mineral soil surface, it is greatly amplified by increased soil burn severity (Doerr et al. 2000, Huffman et al. 2001, Neary et al. 2005).

Soil hydrophobicity usually returns to pre-burn conditions in no more than six years (DeBano 1981). Dyrness and others (1976) have documented a much more rapid recovery of one to three years (Huffman et al. 2001). The persistence of a hydrophobic layer will depend on the strength and extent of hydrophobic chemicals after burning and the many physical and biological factors that can aid in breakdown (DeBano 1981). This variability means that post-fire impacts on watershed conditions are difficult to predict and to quantify.

If hydrophobic soils result from a severe, high-temperature fire, moderate to high surface erosion could occur. The potential for mass failures would be low to moderate because of the overall landtype characteristics within the project area; however, localized slope movement could be possible, especially along roads on steeper mountain slopes.

Geology

Indirectly, a wildfire under severe fire conditions (90th percentile) would burn a large proportion of the project area with flame lengths in excess of 8 feet as displayed in the Current flame length potential map in the EA (Appendix F Figure F.8.). Model outputs estimate that about 2,698 acres of geologically sensitive land types (active slides, inner gorge, and slopes > 65%) would burn with flame lengths in excess of 8 feet. It should be noted that all Alternatives, these acre values are model outputs which were not rounded off, and do not imply accuracy down to the nearest acre. Rather, they should be viewed as rough estimates of the general size of the landscape likely to be affected. There would be no dust generation associated with prescribed burning. However, a wildfire under severe fire conditions (90th percentile) would likely result in use of part of the existing trail system and fire lines in ultramafic areas for suppression activities. It is unlikely that the entire system would be used, so the length used would be less than the total, which is 6.8 miles of trails and 5.6 miles of fire lines in ultramafic areas. Under wildfire conditions it is much more difficult to minimize dust generation, since it isn't possible to wait for moist soil conditions.

Watershed/Hydrology

The no action alternative increases the risk of future high-severity wildfires. Although a high-severity fire is not certain to occur within the project area during a given timeframe, the occurrence of such a fire would increase the potential for impacts to hydrologic systems in severely-burned watersheds. Increased volume of sediment delivered to the stream network would occur. Increased sediment delivery would in turn likely increase turbidity.

Increased sediment delivery from surface erosion would likely peak the first year after the event and then recover gradually over the next 6-10 years. Sediment delivery from mass wasting would persist for longer periods until stabilizing vegetation could recover. Increased sediment delivery to channels is a concern in the New River Watershed since the antidegradation provisions of the Clean Water Act and Basin Plan prohibit an "increase in pollution." In other words, high quality waters must be maintained as such.

In particular, resource managers must continue to prevent, protect and restore conditions in this "Key Watershed" that provides critical refugia for aquatic species. Selection of the no action alternative could result in failure to meet TMDL objectives that limit an increase in sedimentation to no more than 25% over background levels (US Environmental Protection Agency - EPA 2001). Increased stream temperature resulting from reduced shade is also a concern if high-severity, stand replacing wildfire occurs within riparian reserves. These highly productive areas can develop heavy fuels loads capable of supporting stand replacing crown fires, which can alter wildlife habitat, ecosystem function, and contribute to channel erosion (Van de Water et al. 2010).

Changes in site evapotranspiration demands, interception of precipitation by vegetation, and reduced soil infiltration would result in increased runoff, decreased lag time, and increased peak flows. Higher peak flows would increase the likelihood of increased channel and bank scour. If stabilizing bank vegetation and coarse woody debris were also reduced by high-severity fire, streambank stability would likely decrease.

Cumulative Effects

The spatial and temporal bounding for the cumulative effects analysis is described in the Existing Condition section of this report. See pages 9 and 10 above for more detail.

Soils

Since there are no direct effects and indirect effects consist of those associated with a speculative future event, cumulative effects are also contingent upon a speculative future event. The past disturbances were described in the existing situation section. There has been vegetation recovery from previous fires which currently provides sufficient soil cover. Soil productivity losses from previous fires cannot be retrieved however the soils began the process of recovery after the fires burned. Additional wildfires with high burn severity would, if they occurred repeat the loss of soil cover and soil productivity.

Geology

Since there are no direct effects and indirect effects consist of those associated with a speculative future event, cumulative effects are also contingent upon a speculative future event. The past disturbances were described in the existing situation section. Instability created by past events will continue into the future until large trees with large, deep root systems regrow on these sites (100-300 years). Additional wildfires with high burn severity would, if they occurred repeat the loss of slope stability. Karst areas were likely exposed to the smoke of wildfires in the past. Additional wildfires with high burn severity would, if they occurred repeat the exposure of karst to wildlife smoke.

Watershed/Hydrology

Wildfire will almost certainly occur within the project area during the next three decades, the timeframe for which most modelled cumulative disturbances are considered to recover to extent feasible. The severity and size of those fires will determine the cumulative watershed effects of the “no action” alternative. If the pattern of multiple high-severity fires does not persist, sediment delivery from surface erosion would return to background levels. Sediment delivery and disturbance to watershed processes would trend towards background levels over the next three decades. Increased risk of high-severity fire exists under the “no action” alternative because of current fuel loading from previous suppression efforts, changed conditions from many decades of fire suppression, and a continued policy of fire suppression. Fire modeling produced scenarios that would result in increased surface erosion, mass wasting, and increased disturbance levels measured as percent ERA. Modeling results indicated that multiple drainages in the project area are of concern due to high disturbance levels that could potentially impact downstream beneficial uses with another large wildfire.

Alternative 2 – Proposed Action

In order to meet the purpose and need described in Chapter 1 of the EA, the Trinity River Management Unit of the Shasta-Trinity NF proposes to implement prescribed burning on NFS lands encompassing approximately 16,709 acres within the Trinity Alps Wilderness (see chapter 2 of the EA for detailed description of the alternative).

Direct Effects

Soil

The prescribed burn may result in a minor loss of nitrogen (Neary et al. 2005), but this is not expected to have a measurable effect on soil productivity. Based on the amount of high, medium and light severity fire predicted, the organic material on the forest floor (forest soil ground cover) would be maintained at sufficient levels to meet LRMP standards. Because the groundcover would remain, there would not be detrimental increases in surface erosion. Isolated pockets of soil may exist that do not currently meet forest groundcover requirements. These areas would be unlikely to burn under the prescription and should not be further impacted.

Geology

The direct effects of the prescribed burn would be predominantly low vegetation severity fire which would kill only small understory vegetation and leave the bulk of the soil cover. The Vegetation Fire Severity section refers to vegetation burn severity in the wilderness portion only from the 2008 Iron Complex at 18%high severity with an additional 25%/at moderate severity. The fire model (ArcFuels+Flammap+FOFEM) estimate of less than 10% of the prescribed burn is expected to occur at high and 15% moderate vegetation burn severity is believable knowing that under more favorable weather conditions the fire would respond less aggressively. However, project design features to avoid high severity, and ensure lower-severity burns on active slides and slide prone areas would be applied. The single known cave within the project area boundary is not located within a treatment area. In the event another cave is discovered, the project design features address cave protection. Trails and fire lines underlain by ultramafic rock would be used in the project. Under dry conditions, soil disturbances in these areas can generate dust with the potential to contain natural asbestos. Project design features will minimize this potential. In summary for Alternative 2, direct effects consist of:

1. **Fire Severity on Geologically Sensitive Lands-** Prescribed fire would occur in a north-south strip through the center of the project area and around the perimeter. See the Flame length potential map for Alternative 2 in the EA (Appendix F Figure F.11.). Flame lengths would predominantly be less than 8 feet, and the fire model estimates that flame lengths > 8 feet would occur on about 650 acres of geologically sensitive land (active slides, inner gorge, and slopes > 65%).
2. **Vegetation Disturbance and Smoke Near Marble Outcrops-** No vegetation disturbance is anticipated within 1000 feet of any known cave or marble outcrops. The distance from the known cave to the nearest prescribed fire area is approximately one mile. The distribution, concentration, and persistence of the smoke produced is not currently predictable and would depend on air currents. Wildfire and smoke are part of the natural environment, and such smoke would not be alien to the cave or karst area.
3. **Dust in Ultramafic Areas-** Foot traffic on trails and soil disturbance on fire lines would occur as part of the prescribed burning and would produce dust if implemented under dry

conditions. The total length of trails in ultramafic rock, which might be used by crews is about 6.8 miles, and total length of fire line is about 5.6 miles. Project design features would reduce or limit dust production.

Watershed/Hydrology

The prescribed burn treatment would be primarily a mosaic of low-intensity fire and unchanged vegetation within areas with very low or low burn probabilities with up to 10% of the area having patches of high and up to 15% moderate soil burn severities. Short-term increases in surface erosion would likely occur in some areas; however, the increase would not cause downstream impacts to beneficial resources. Trends in sediment delivery over time would be toward background levels. The low-intensity fire treatments would not affect canopy cover in riparian reserves; therefore changes in stream temperature are not anticipated. Project design features such as limiting how much of each sub-watershed can be burned per year and only allowing backing fire in riparian reserves would help to insure that soil and water resources are adequately protected.

Indirect Effects

Soil

Based on the site specific fire model described earlier, the prescribed fire is unlikely to create large connected areas of disturbed soil within treated areas. Large areas of heat penetration into the soil surface during burning would be minimal. It is possible that there would small areas of heat penetration into the soil. In addition, some of the seedbed may be disturbed in isolated spots, which could display less vegetative growth over the short term. Erosion from the proposed activities would be minimal because the patchiness of the burns would retain sufficient cover to protect the soil. The proposed vegetation and fuel treatments would reduce the chance that a wildfire could have as severe an effect on the soils and surrounding private property in treated areas as it could in untreated areas because there would be a reduction in the tons per acre of dead and dying fuels on treated sites. Predicted changes with fire-lines underlain by ultramafic rock could increase dust, but exposure would be very low to none if soil is moist.

Geology

Indirect effects from Alternative 2 are not expected to measurably increase mass wasting or debris flow activity in the project area above the existing rates. This is because direct effects would be predominantly low-severity burning of understory vegetation and forest floor litter. Exceptions would be small localized areas of higher severity burn on sensitive geologic lands as quantified above in the direct effects section. The indirect effects of higher severity fire (flame lengths > 8 feet) on a small amount of geologically sensitive land would be loss of root support and evapotranspiration. This would likely result in a small increase in landslide potential at those specific sites. This effect is offset by a reduced potential for a large high severity fire. Since no vegetation disturbance would occur within 1000 feet of marble outcrops, no indirect effects are anticipated. No indirect effects of smoke are anticipated. Indirect effects of natural asbestos include long term health issues when inhaled. By application of project design features, inhalation of fibers would be avoided, and indirect effects prevented.

Watershed/Hydrology

Short-term increases in sedimentation with its associated turbidity and pH are possible after the initial post-implementation precipitation events produce runoff. Increases in turbidity and pH above background levels would be difficult to detect and would not be anticipated to impact downstream beneficial uses. High quality waters found in the New River Watershed are best protected under this alternative because the alternative best addresses the antidegradation provisions of the Clean Water Act and Basin Plan which prohibits an "increase in pollution."

Cumulative Effects

Soils

The direct effects and indirect effects described in previous sections would be added to those from past wildfires and actions described in the existing condition section. Since there has been vegetation recovery from previous fires which currently provides sufficient soil cover, the direct and indirect effects express the likely effects of the project. Although soil productivity losses from previous fires cannot be retrieved, the soils began the process of recovery after the fires burned. The direct and indirect effects of this alternative would have minimal additional effects on soil productivity. This alternative will reduce the likelihood of additional wildfires that could burn with high burn severity. This is expected to reduce the future loss of soil cover and soil productivity from high severity wildfire.

Geology

The direct and indirect effects described in previous sections would be added to these from past wildfires and actions described in the existing conditions section. Since instability created by past events will continue into the future until large trees with large, deep root systems regrow on these sites (100-300 years), the direct and indirect effects of this alternative would add to this. This alternative will reduce the likelihood of additional wildfires that could burn with high burn severity. This is expected to reduce the future loss of slope stability from high severity wildfire. Karst areas were likely exposed to the smoke of wildfires in the past. This alternative is expected to reduce the future expose of karst to smoke from high severity wildfires.

Watershed/Hydrology

Results of the surface erosion model analysis (Table 10 below) shows that the largest change in anticipated disturbance levels in the Six-mile Virgin Creek drainage however the existing low level of disturbance combined with the proposed activity is still low enough it would not increase the risk of adverse cumulative watershed effects from the present low risk level. Recovery from the minor increases in surface erosion would be expected the first year and as vegetation is reestablished and ground cover develops and the site would trend to background levels within a year or two, at most. The increase in sediment delivery from mass wasting as a result of the proposed treatments would be negligible.

The ERA model shows very little increase in disturbance levels. The most noticeable changes to the predicted risk ratio are seen in individual 8^{th} field sub-drainages (HUC8). While some of the numerical values changed, the CWE analysis indicates that the proposed treatment will result in such a minimal degree of impact there will be no change to overall disturbance risk levels to any hydrologic units except one within Barron Creek – Caraway Creek that changes to a moderate disturbance level (see Table 11d below). There is also another hydrologic unit that was brought very near to a moderate disturbance level in the same drainage. Disturbance could result in short-term increases in erosion and sedimentation would be localized, and the effects would dissipate downstream with increasing stream order.

The proposed treatments would not – and are not designed to – prevent wildfire from occurring within the project area in the next decade; however, the likelihood of smaller and/or lower-severity wildfires is greater than if the treatments were not implemented. The resulting cumulative watershed effects from future wildfires of lower severity would be less likely to impact downstream beneficial uses.

Cumulative effects modeling results of the proposed Alternative 2 treatments are displayed in Tables 10, 11, 12a-12d on pages 37-41.

Table 10. USLE-based surface erosion sediment delivery for Alternative 2.

Drainage (HUC7)	Background*	Existing*	Risk Ratio Existing	Risk Ratio Alternative 2	Acres
Eightmile Creek	224	353	0.14	0.18	6,966
Sixmile Creek-Virgin Creek	253	394	0.14	0.23	9,525
Twomile Creek-Virgin Creek	193	200	0.01	0.06	7,506
North Fork Eagle Creek	141	141	0.00	0.17	7,696
Eagle Creek-Slide Creek	197	206	0.01	0.04	10,056
Lower Slide Creek	164	185	0.03	0.08	8,254
Quinby Creek	420	431	0.01	0.01	5,629
Barron Creek-Caraway Creek	453	498	0.02	0.11	10,596

*Delivered sediment (cubic yards/year).

Table 11. Geologic based – Mass wasting sediment delivery for Alternative 2.

Drainage (HUC7)	Background*	Existing*	Risk Ratio	Risk Ratio Alternative 2	Acres
Eightmile Creek	29,335	86,152	0.97	0.97	6,966
Sixmile Creek-Virgin Creek	31,176	102,344	1.14	1.15	9,525
Twomile Creek-Virgin Creek	40,063	92,304	0.65	0.67	7,506
North Fork Eagle Creek	10,566	42,256	1.50	1.51	7,696
Eagle Creek-Slide Creek	61,132	150,755	0.73	0.73	10,056
Lower Slide Creek	29,329	51,412	0.38	0.38	8,254
Quinby Creek	12,310	44,799	1.32	1.32	5,629
Barron Creek-Caraway Creek	15,546	32,935	0.56	0.56	10,596

*Delivered sediment (cubic yards/10-year).

Table 12a. 5th Field Watershed ERA Model for Alternative 2 (2020).

Watershed (HUC5)	ERA	ERA Alternative 2	Risk Ratio	Risk Ratio Alternative 2	Risk Ratio Change	Disturbance Level	Acres
New River	1926.0	2760.2	0.09	0.13	0.04	LOW	149,364

Table 12b. Sub-watershed ERA Model for Alternative 2.

Sub-watershed (HUC6)	ERA	ERA Alternative 2	Risk Ratio	Risk Ratio Alternative 2	Risk Ratio Change	Disturbance Level	Acres
Eagle Creek	117.7	466.6	0.03	0.11	0.08	LOW	21,629
Sixmile Creek	48.85	398.8	001	0.12	0.11	LOW	26,008
Upper New River	416.9	552.5	0.14	0.18	0.04	LOW	21,396

Table 12c. Drainage (HUC7) ERA Model for Alternative 2.

Drainage (HUC7)	ERA	ERA Alternative 2	Risk Ratio	Risk Ratio Alternative 2	Risk Ratio Change	Disturbance Level	Acres
Barron Creek-Caraway Creek	260.6	395.9	0.18	0.27	0.09	LOW	6,966
Eagle Creek-Slide Creek	3.7	61.2	0.00	0.04	0.04	LOW	9,525
Eightmile Creek	2.4	60.2	0.00	0.06	0.06	LOW	7,506
Lower Slide Creek	57.2	133.5	0.05	0.12	0.07	LOW	7,696
North Fork Eagle Creek	0.6	215.5	0.00	0.02	0.02	LOW	10,056
Quinby Creek	60.4	60.7	0..08	0.08	0.00	LOW	8,254
Sixmile Creek-Virgin Creek	27.6	231.2	0.02	0.17	0.15	LOW	9,525
Twomile Creek-Virgin Creek	88.66	107.7	0.02	0.10	0.08	LOW	7,506

Table 12d. 8th Field Watershed ERA Model for Alternative 2.

Drainage (HUC7)	Sub-drainage (HUC8)	ERA	ERA Alternative 2	Risk Ratio	Risk Ratio Alt2	Risk Ratio Change	Disturbance Level	Acres
Eightmile Creek	1801021110010101	16.5	38.8	0.06	0.15	0.09	LOW	1,895
	1801021110010102	3.6	27.1	0.01	0.09	0.08	LOW	2,072
	1801021110010103	6.3	18.4	0.03	0.09	0.06	LOW	1,494

Drainage (HUC7)	Sub-drainage (HUC8)	ERA	ERA Alternative 2	Risk Ratio	Risk Ratio Alt2	Risk Ratio Change	Disturbance Level	Acres
	1801021110010104	0.5	0.5	0.00	0.00	0.00	LOW	1,507
Sixmile Creek-Virgin Creek	1801021110010201	4.3	53.7	0.02	0.23	0.19	LOW	1,634
	1801021110010202	2.8	50.4	0.01	0.23	0.22	LOW	1,551
	1801021110010203	25.9	55.2	0.09	0.20	0.11	LOW	1,962
	1801021110010204	9.1	12.9	0.04	0.05	0.01	LOW	1,832
	1801021110010205	7.8	81.3	0.02	0.23	0.21	LOW	2,546
Twomile Creek- Virgin Cr	1801021110010301	1.7	16.3	0.00	0.05	0.05	LOW	2,401
	1801021110010302	12.4	23.4	0.04	0.07	0.03	LOW	2,506
	1801021110010303	7.1	70.1	0.02	0.19	0.03	LOW	2,599
North Fork Eagle Creek	1801021110020101	4.5	63.3	0.01	0.19	0.18	LOW	2,343
	1801021110020102	0.0	43.8	0.00	0.16	0.16	LOW	1,897
	1801021110020103	0.0	56.5	0.00	0.20	0.20	LOW	1,981
	1801021110020104	0.3	56.1	0.00	0.27	0.27	LOW	1,476

Eagle Creek – Slide Creek	1801021110020201	6.0	24.4	0.02	0.07	0.05	LOW	2,337
	1801021110020202	4.8	5.5	0.02	0.02	0.02	LOW	2,188
	1801021110020203	7.5	24.3	0.02	0.08	0.06	LOW	2,278
	1801021110020204	4.6	4.6	0.03	0.03	0.0	LOW	1,253
	1801021110020205	0.0	0.0	0.00	0.00	0.0	LOW	526
	1801021110020206	1.6	1.6	0.02	0.02	0.0	LOW	657
	1801021110020207	2.1	23.7	0.02	0.21	0.19	LOW	817
Lower Slide Creek	1801021110020301	22.7	41.0	0.06	0.11	0.05	LOW	2,618
	1801021110020302	12.0	23.8	0.07	0.14	0.07	LOW	1,247
	1801021110020303	20.0	29.1	0.06	0.09	0.03	LOW	2,309
	1801021110020304	20.3	57.4	0.07	0.20	0.13	LOW	2,080
Upper East Fork New River	1801021110030101	6.0	6.0	0.02	0.02	0.0	LOW	2,248
	1801021110030102	6.0	6.0	0.01	0.01	0.0	LOW	2,582
	1801021110030103	4.4	4.4	0.01	0.01	0.0	LOW	2,075
	1801021110030104	5.8	5.8	0.02	0.02	0.0	LOW	2,372
Milk Creek-Pony Creek	1801021110030201	0.8	0.8	0.00	0.00	0.0	LOW	2,794
	1801021110030202	0.2	0.2	0.00	0.00	0.0	LOW	2,652
Middle East Fork New River	1801021110030301	5.4	5.4	0.01	0.01	0.0	LOW	1,464
	1801021110030302	45.3	45.3	0.11	0.11	0.0	LOW	1,785
Lower East Fork New River	1801021110030401	26.2	26.2	0.17	0.17	0.0	LOW	988
	1801021110030402	23.7	23.7	0.09	0.09	0.0	LOW	1,681
	1801021110030403	96.2	96.20	0.20	0.20	0.0	LOW	2,956
Quinby Creek	1801021110040101	26.3	26.4	0.07	0.07	0.0	LOW	2,580
	1801021110040102	10.8	11.0	0.08	0.08	0.0	LOW	976
	1801021110040103	23.3	23.3	0.08	0.08	0.0	LOW	2,074

Barron Creek – Caraway Creek	1801021110040201	35.2	77.0	0.10	0.22	0.12	LOW	2,529
	1801021110040202	26.4	88.4	0.14	0.47	0.33	MOD*	1,340
	1801021110040203	49.4	65.2	0.29	0.39	0.10	LOW	1,196
	1801021110040204	35.0	49.0	0.13	0.18	0.05	LOW	1,969
	1801021110040205	71.0	72.8	0.36	0.37	0.01	LOW	1,421
	1801021110040206	43.5	43.5	0.15	0.15	0.0	LOW	2,133

Alternative 3

Alternative 3 was developed to respond to the concerns over fuels conditions within the Virgin Creek drainage. In addition to all of the treatments under the proposed action (see above), approximately 2,379 acres would be treated in that drainage, for a total of about 19,088 total treatment acres. Detailed treatment areas are described in Chapter 2 of the EA.

Direct Effects

Soil

The prescribed fire would result in a minor loss of nitrogen slightly higher than Alternative 2 because more area would be burned, but this would have no measurable effect on soil productivity. The overall forest floor would be adequately maintained. The prescribed fire is designed to meet forest soil ground cover requirements in treated areas. The maintenance of the groundcover would minimize the risk of detrimental increases in surface erosion. Isolated pockets of soil that do not currently meet forest groundcover requirements may exist. These areas would be unlikely to burn under the prescription and should not be further impacted.

Geology

This alternative would treat more area than Alternative 2. The direct effects of the prescribed burn would be predominantly low-severity fire, which would consume only small understory vegetation and leave the bulk of the soil cover. Based on an overlay of the modeled flame length map and the geomorphic map, it is estimated that 723 acres of fire with flame length > 8' would occur on unstable or sensitive lands (active landslides, inner gorges, and steep lands (slopes > 65%). From the fire model, when flame lengths exceed this value, much of the overstory is likely to be killed. Project design features to avoid or ensure low-intensity burns on active slides and slide prone areas would be applied. The single known cave within the project area is outside the proposed treatment areas (about ½ mile), but closer to treatment areas than under Alternative 2. Smoke from prescribed fire could reach the cave, depending on air flow patterns. Based on a GIS overlay, no other mapped marble outcrops are within 1000 feet of proposed treatment areas.

In summary for Alternative 3, direct effects are:

1. **Fire Severity on Geologically Sensitive Lands-** Prescribed fire would occur in a north-south strip through the center of the project area, around the perimeter, and on several east-

west trending ridges in the west half. See the Flame length potential map for Alternative 3 in the EA (Appendix F Figure F.14.). Flame lengths would be predominantly less than 8 feet, and the fire model estimates that flame lengths > 8 feet would occur on about 723 acres of geologically sensitive land (active slides, inner gorge, and slopes > 65%). This is about 73 acres more than Alternative 2.

2. **Vegetation Disturbance and Smoke Near Marble Outcrops-** No vegetation disturbance is anticipated within 1000 feet of any known cave or marble outcrops. The distance from the known cave to the nearest prescribed fire area would be about a half mile. The distribution, concentration, and persistence of the smoke produced is not currently predictable and would depend on air currents. Wildfire and smoke are part of the natural environment, and such smoke would not be alien to the cave or karst area.
3. **Dust in Ultramafic Areas-** Foot traffic on trails and soil disturbance on fire lines would occur as part of the prescribed burning and would produce dust if done under dry conditions. The total length of trails in ultramafic rock, which might be used by crews is about 6.8 miles, and total length of fire line is about 5.6 miles. This is the same as for Alternative 2. Resource protection measures would reduce or limit dust production.

Watershed/Hydrology

Direct effects would be slightly higher under this alternative than under Alternative 2 because more acres would be treated. As with Alternative 2, the prescribed burn would be primarily a mosaic of low-intensity fire and unchanged vegetation with in areas with very low or low burn probabilities. Areas of moderate- and high-intensity fire would occur. Short-term increases in surface erosion would likely occur in some areas; however, the increase would not cause downstream impacts to beneficial resources. Trends in sediment delivery would be toward background levels. The low-intensity treatments would not affect canopy cover; therefore, changes in stream temperature are not anticipated.

High quality waters found in the New River Watershed will be maintained as in Alternative 2 meeting the antidegradation provisions of the Clean Water Act and Basin Plan which prohibits an "increase in pollution."

Indirect Effects

Soil

The additional treatments under Alternative 3 would enhance the effectiveness of overall project (see the project Fire, Fuels, Air Quality and Vegetation Report).

Based on the site specific fire model described earlier, the prescribed fire is unlikely to create large connected areas of disturbed soil within treated areas. Large areas of heat penetration into the soil surface during burning would be minimal. It is possible that there would small areas of heat penetration into the soil. In addition, some of the seedbed may be disturbed in isolated spots, which could display less vegetative growth over the short term. Erosion from the proposed activities would be minimal because the patchiness of the burns would retain sufficient cover to protect the soil.

The proposed vegetation and fuel treatments would reduce the chance that a wildfire could have as severe an effect on the soils in treated areas as it could in untreated areas because there would be a reduction in the tons per acre of dead and dying fuels on treated sites.

Geology

The indirect effects of Alternative 3 would be very similar to those of Alternative 2, though slightly more area would be burned. CWE landslide model results are nearly identical between the two action alternatives. The single known cave within the project area is outside the proposed treatment areas under both action alternatives but closer to burn areas under this alternative. It would be protected by project design features. Since no direct effects are anticipated within 1000 feet of karst areas, no indirect effects are anticipated. Indirect effects relative to natural asbestos hazards would be the same as for Alternative 2.

Watershed/Hydrology

As with Alternative 2, short-term increases in sedimentation and the associated turbidity and pH are possible after the initial post-implementation precipitation events that produce runoff. Increases in turbidity and pH above background levels would be difficult to detect and would not be anticipated to impact downstream beneficial uses. The potential for indirect effects under this alternative are slightly higher than under Alternative 2 because more acres would be treated.

Cumulative Effects

Soils

The direct effects and indirect effects described in previous sections would be added to those from past wildfires and actions described in the existing condition section. Since vegetation recovery from previous fires is currently providing sufficient soil cover, the direct and indirect effects express the likely effects of the project. Although soil productivity losses from previous fires cannot be retrieved, the soils began the process of recovery after the fires burned. The direct and indirect effects of this alternative would have minimal additional effects on soil productivity. This alternative will reduce the likelihood of additional wildfires that could burn with high burn severity to a greater extent than alternative 2. This is expected to reduce the future loss of soil cover and soil productivity from high severity wildfire to a greater extent than alternative 2.

Geology

The direct and indirect effects described in previous sections would be added to these from past wildfires and actions described in the existing condition section. Since instability created by past events will continue into the future until large trees with large, deep root systems regrow on these sites (100-300 years), the direct and indirect effects of this alternative would add to this. This alternative will reduce the likelihood of additional wildfires that could burn with high burn severity. This is expected to reduce the future loss of slope stability from high severity wildfire to a greater extent than alternative 2. Karst areas were likely exposed to the smoke of wildfires in the past. This alternative is expected to reduce the future expose of karst to smoke from high severity wildfires to a greater extent than alternative 2.

Watershed/Hydrology

Results of the surface erosion model analysis show that the largest change in risk is 17% in the North Fork Eagle Creek drainage, and that the overall highest risk of 25% is in the Twomile Creek – Virgin Creek drainage.

Recovery from these increases in surface erosion would be realized substantially in the first year, and then continue to trend toward background within a few years. The increase in sediment delivery from mass wasting from the proposed treatments would be negligible.

The ERA model shows very little increase in disturbance levels, most hydrologic units are the same as Alternative 2 since the proposed treatments are exactly the same. The CWE analysis indicates that one sub-drainages (HUC8) – 1801021110040202 within the Barron Creek – Caraway Drainage would change from a Disturbance Level of Low to Moderate, just as it does in Alternative 2. There are no new changes that change overall risk levels as related to disturbance, even in the areas with additional areas proposed for treatments. Disturbance under either action alternative could result in short term increases in sedimentation that is expected to be localized, and the effects would dissipate downstream with increasing stream order. The cumulative watershed effects modeling results of the proposed treatments for Alternative 3 are displayed tables 13, 14 and 15a-15d on pages 44-48.

Table 13. USLE-based surface erosion sediment delivery for Alternative 3.

Drainage (HUC7)	Background*	Existing*	Risk Ratio Existing	Risk Ratio Alternative 3	Acres
Eightmile Creek	224	353	0.14	0.18	6,966
Sixmile Creek-Virgin Creek	253	394	0.14	0.25	9,525
Twomile Creek-Virgin Creek	193	200	0.01	0.09	7,506
North Fork Eagle Creek	141	141	0.00	0.17	7,696
Eagle Creek-Slide Creek	197	206	0.01	0.04	10,056
Lower Slide Creek	164	185	0.03	0.08	8,254
Quinby Creek	420	431	0.01	0.01	5,629
Barron Creek-Caraway Creek	453	498	0.02	0.11	10,596

*Delivered sediment (cubic yards/year).

Table 14. Geologic-based mass wasting sediment delivery for Alternative 3.

Drainage (HUC7)	Background*	Existing*	Risk Ratio	Risk Ratio Alternative 3	Acres
Eightmile Creek	29,335	86,152	0.97	0.97	6,966
Sixmile Creek-Virgin Creek	31,176	102,344	1.14	1.15	9,525
Twomile Creek-Virgin Creek	40,063	92,304	0.65	0.67	7,506
North Fork Eagle Creek	10,566	42,256	1.50	1.51	7,696

Drainage (HUC7)	Background*	Existing*	Risk Ratio	Risk Ratio Alternative 3	Acres
Eagle Creek-Slide Creek	61,132	150,755	0.73	0.73	10,056
Lower Slide Creek	29,329	51,412	0.38	0.38	8,254
Quinby Creek	12,310	44,799	1.32	1.32	5,629
Barron Creek-Caraway Creek	15,546	32,935	0.56	0.56	10,596

*Delivered sediment (cubic yards/10-year).

Table 15a. Watershed (HUC5) ERA Model for Alternative 3.

Watershed (HUC5)	ERA	ERA Alternative 3	Risk Ratio	Risk Ratio Alternative 3	Risk Ratio Change	Disturbance Level	Acres
New River	1926	2780	0.09	0.13	0.04	LOW	149,364

Table 15b. Subwatershed (HUC6) ERA Model for Alternative 3. (Shaded cells are unchanged between Alt 2 & 3)

Sub-watershed (HUC6)	ERA	ERA Alternative 3	Risk Ratio	Risk Ratio Alternative 3	Risk Ratio Change	Disturbance Level	Acres
Lower New River	117.7	466.6	0.03	0.11	0.08	LOW	21,629
Sixmile Creek	48.85	428.6	0.01	0.13	0.12	LOW	23,998
Upper New River	416.9	552.5	0.14	0.18	0.04	LOW	21,396

Table 15c. Drainage (HUC7) ERA Model for Alternative 3. (Shaded cells are unchanged between Alt 2 & 3)

Drainage (HUC7)	ERA	ERA Alternative 3	Risk Ratio	Risk Ratio Alternative 3	Risk Ratio Change	Disturbance Level	Acres
Barron Creek-Caraway Creek	260.6	395.9	0.18	0.27	0.09	LOW	6,966
Eagle Creek-Slide Creek	3.7	61.2	0	0.04	0.04	LOW	9,525
Eightmile Creek	2.4	62.3	0	0.06	0.06	LOW	7,506
Lower Slide Creek	57.2	133.5	0.05	0.12	0.07	LOW	7,696
North Fork Eagle Creek	0.6	215.5	0	0.02	0.02	LOW	10,056
Quinby Creek	60.4	60.7	0..08	0.08	0	LOW	8,254
Sixmile Creek-Virgin Creek	27.6	243.4	0.02	0.18	0.16	LOW	9,525
Twomile Creek-Virgin Creek	88.66	123.1	0.02	0.12	0.1	LOW	7,506

Table 15d. Sub-drainage (HUC8) ERA Model for Alternative 3. (Shaded cells are unchanged between Alt 2 & 3)

Drainage (HUC7)	Sub-drainage (HUC8)	ERA	ERA Alternative 3	Risk Ratio	Risk Ratio Alt3	Risk Ratio Change	Disturbance Level	Acres
Eightmile Creek	1801021110010101	16.5	38.8	0.06	0.15	0.09	LOW	1,895
	1801021110010102	3.6	27.1	0.01	0.09	0.08	LOW	2,072
	1801021110010103	6.3	21.4	0.03	0.1	0.07	LOW	1,494
	1801021110010104	0.5	0.5	0	0	0	LOW	1,507
Sixmile Creek-Virgin Creek	1801021110010201	4.3	53.7	0.02	0.23	0.19	LOW	1,634
	1801021110010202	2.8	50.4	0.01	0.23	0.22	LOW	1,551
	1801021110010203	25.9	56.0	0.09	0.20	0.11	LOW	1,962
	1801021110010204	9.1	18.7	0.04	0.07	0.03	LOW	1,832
	1801021110010205	7.8	86.9	0.02	0.24	0.22	LOW	2,546
Twomile Creek-Virgin Creek	1801021110010301	1.7	19.9	0	0.06	0.06	LOW	2,401
	1801021110010302	12.4	26.6	0.04	0.08	0.04	LOW	2,506
	1801021110010303	7.1	78.6	0.02	0.22	0.2	LOW	2,599
North Fork Eagle Creek	1801021110010301	4.5	63.3	0.01	0.19	0.18	LOW	2,343
	1801021110010302	0	43.8	0	0.16	0.16	LOW	1,897
	1801021110010303	0	56.5	0	0.2	0.2	LOW	1,981
Eagle Creek – Slide Creek	1801021110020101	0.3	56.1	0	0.27	0.27	LOW	1,476
	1801021110020102	6	24.4	0.02	0.07	0.05	LOW	2,337
	1801021110020103	4.8	5.5	0.02	0.02	0.02	LOW	2,188
	1801021110020104	7.5	24.3	0.02	0.08	0.06	LOW	2,278
	1801021110020206	30.61	30.61	0.33	0.33	0.00	LOW	657
	1801021110020207	9.74	15.13	0.09	0.13	0.04	LOW	817
Lower Slide Creek	1801021110020301	22.7	41	0.06	0.11	0.05	LOW	2,618
	1801021110020302	12	23.8	0.07	0.14	0.07	LOW	1,247
	1801021110020303	20	29.1	0.06	0.09	0.03	LOW	2,309

	1801021110020304	20.3	57.4	0.07	0.2	0.13	LOW	2,080
Upper East Fork New River	1801021110030101	6	6	0.02	0.02	0	LOW	2,248
	1801021110030102	6	6	0.01	0.01	0	LOW	2,582
Milk Creek-Pony Creek	1801021110030201	4.4	4.4	0.01	0.01	0	LOW	2,075
	1801021110030202	5.8	5.8	0.02	0.02	0	LOW	2,372
Middle East Fork New River	1801021110030301	0.8	0.8	0	0	0	LOW	2,794
	1801021110030302	0.2	0.2	0	0	0	LOW	2,652
Lower East Fork New River	1801021110030401	5.4	5.4	0.01	0.01	0	LOW	1,464
	1801021110030402	45.3	45.3	0.11	0.11	0	LOW	1,785
	1801021110030403	26.2	26.2	0.17	0.17	0	LOW	988
Quinby Creek	1801021110040101	23.7	23.7	0.09	0.09	0	LOW	1,681
	1801021110040102	96.2	96.2	0.2	0.2	0	LOW	2,956
	1801021110040103	26.43	26.43	0.36	0.36	0	LOW	526
	1801021110040201	30.61	30.61	0.33	0.33	0	LOW	657
	1801021110040202	9.74	15.13	0.09	0.13	0.04	LOW	817
Barron Creek – Caraway Creek	1801021110040203	35.2	77	0.1	0.22	0.12	LOW	2,529
	1801021110040204	26.4	88.4	0.14	0.47	0.33	MOD	1,340
	1801021110040205	49.4	65.2	0.29	0.39	0.1	LOW	1,196
	1801021110040206	35	49	0.13	0.18	0.05	LOW	1,969
	1801021110030201	71	72.8	0.36	0.37	0.01	LOW	1,421
	1801021110030202	43.5	43.5	0.15	0.15	0	LOW	2,133

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Appendix A – Glossary

Anadromous fish bearing streams – streams that support fish species that return from the ocean to reproduce.

Burn probability modeling – a modeling method that simulates the effect of the ignition and spread of a very large number of fires on a raster landscape to calculate spatially explicit outputs (i.e. likelihood of ignition) on a landscape level; model used to calculate **burn probabilities** on a given landscape.

Communities at risk – identified communities within the WUI at high risk to wildfire, listed, published and maintained in the state of California by the California Fire Alliance. Initially published in the Federal Register, future updates of this list will be made available electronically from the National Interagency Fire Center World Wide Web/Internet home page at http://www.nifc.gov.

Crown fire – a fire burning in the crowns of forest vegetation; crown fire can be passive, active or independent.

Cumulative watershed effects – environmental changes that are affected by more than one land-use activity and that are influenced by processes involving the generation or transport of water and sediment.

Flame length – the average distance from the base of the flame to its highest point. Flame length can be measured in the field and is related to fireline intensity.

Fire intensity – the rate of energy release per unit length of flaming front. The amount of heat one would be exposed to per second while standing immediately in front of the fire.

Vegetation Fire severity – the magnitude of fire effect on organisms, species, and the environment. Commonly applied to a number of ecosystem components including – but not restricted to – soils, vegetation, trees, animals and watersheds. Vegetation-based fire severity (Miller et al 2009) is described as follows:

- Unchanged = no fire effects
- Low = l0-25 % mortality
- Moderate = 26 to 75% mortality
- High = greater than 75%

Fire regime – the long-term fire pattern characteristics of an ecosystem described as a combination of seasonality, frequency, spatial complexity, intensity, duration and scale.

Fire return interval – the length of time between fires on a particular landscape.

Prescribed fire –a fire treatment to meet one or more specific management objectives. Prescribed fires follow site-specific documents directing their preparation, administration and implementation.

Soil organic matter – includes amorphous and fine organic matter that makes up the O horizon, needles and twigs, and coarser materials such as branches and logs. The amount of organic material on top of the mineral soil should be maintained at levels to sustain soil microorganisms and provide for nutrient cycling. The size, amount, and distribution of organic matter maintained on the mineral soil on a long term basis should be consistent with the amounts that occur given the local ecological type, climate, and normal fire return interval for the area. Generally the desired condition is most related to finer sizes of organic matter, which contain the highest concentration of nutrients. It is important to note that an excess of organic matter on the mineral soil beyond the desired condition can pose a risk of adverse soil effects from fire.

Soil survey – a systematic examination, description, classification, and mapping of the soils in a given area. Soil surveys may be conducted at various scales or orders ranging from very detailed surveys of small parcels (1st order) to general surveys of very large regions (5th order). Refer to table A.1 below.

Table A.1. Soil survey orders and characteristics

Level of data needed	Field procedures	Minimum-size delineation (hectares)1	Typical components of map units2	Kind of map units	Appropriate scales for field mapping and publications
1st order – Very intensive (i.e., experimental plots or individual building sites.)	The soils in each delineation are identified by transecting or traversing. Soil boundaries are observed throughout their length. Remotely sensed data are used as an aid in boundary delineation.	1 or less	Phases of soil series, miscellaneous areas.	Mostly consociations, some complexes, miscellaneous areas.	1:15,840 or larger
2nd order – Intensive (e.g. general agriculture, urban planning.)	The soils in each delineation are identifies by field observations and by remotely sensed data. Boundaries are verified at closely spaced intervals.	0.6 to 4	Phases of soil series, miscellaneous areas, few named at a level above the series.	Consociations, complexes; few associations and undifferentiated groups.	1:12,000 to 1:31,680
3rd order – Extensive (i.e., range or community planning.)	Soil boundaries plotted by observation and interpretation of remotely sensed data. Soil boundaries are verified by traversing representative areas	1.6 to 16	Phases of soil series or taxa above the series; or miscellaneous areas.	Mostly associations or complexes, some consociations and undifferentiated groups.	1:20,000 to 1:63,360

Level of data needed	Field procedures	Minimum-size delineation (hectares)1	Typical components of map units2	Kind of map units	Appropriate scales for field mapping and publications
	and by some transects.				
4th order – Extensive (e.g., general soil information for broad statements concerning land-use potential and general land management.)	Soil boundaries plotted by interpretation of remotely sensed data. Boundaries are verified by traversing representative areas and by some transects.	16 to 252	Phases of soil series or taxa above the series or miscellaneous areas.	Mostly associations; some complexes, consociations and undifferentiated groups.	1:63,360 to 1:250,000
5th order – Very extensive (e.g., regional planning, selections of areas for more intensive study.)	The soil patterns and composition of map units are determined by mapping representative ideas and like areas by interpretation of remotely sensed data. Soils verified by occasional onsite investigation or by traversing.	252 to 4,000	Phases of levels above the series, miscellaneous areas.	Associations; some consociations and undifferentiated groups.	1:250,000 to 1:1,000,000 or smaller

1. This is about the smallest delineation allowable for readable soil maps (see Table 2-2). In practice, the minimum-size delineations are generally larger than the minimum-size shown.

2. Where applicable, all kinds of map units (consociations, complex, and associations, undifferentiated) can be used in any order of soil survey.

Watershed – the entire land area that drains to a specific point along a stream. Watersheds are usually delineated by Hydrologic Unit Codes (HUC). For example:

- A 5th field watershed (5th field HUC) ranges from about 40,000 to 250, 000 acres in size.
- A 6th field watershed (6th field HUC) ranges from about 10,000 to 40,000 acres in size.
- A 7th field watershed (7th field HUC) ranges from about 2,500 to 10,000 acres in size.

See http://pubs.usgs.gov/wsp/wsp2294/ for more information.

Appendix B – Project-Specific BMPs

Best Management Practices (BMPs) were developed to comply with Section 208 of the Clean Water Act. BMPs have been certified by the State Water Quality Resources Control Board and approved by the Environmental Protection Agency (EPA) as the most effective way of protecting water quality from impacts stemming from non-point sources of pollution. These practices have been applied to forest activities and have been found to be effective in protecting water quality on the Shasta-Trinity NF. Specifically, effective application of the US Forest Service Region 5 BMPs has been found to maintain water quality that is in conformance with the Water Quality Objectives in the North Coast Regional Water Quality Control Board's (NCRWQCB) Basin Plan.

Forest Service Region 5 BMPs have been monitored and modified since their original implementation in 1979 to make them more effective. Numerous on-site evaluations by the NCRWQCB have found the practices to be effective in maintaining water quality and protecting beneficial uses. The Forest monitors the implementation and effectiveness of BMPs on randomly selected projects each year As of February 2013 there were 997 evaluations completed on the Forest with soil and water protection rated as effective at 73% of the sites and functional implementation of BMPs at 88% of the sites evaluated (USDA 2013).

The following list of BMPs would be implemented as part of either action alternative. A description of the objective of each BMP is included, as well as how each practice would be specifically implemented. For additional information on the BMPs and their objectives, see the National Best Management Practices for Water Quality Management on National Forest System Lands. Vol 1: National Core BMP Technical Guide 2012 and the Region 5 Water Quality Management handbook (R5 FSH 2509.22 (USDA Forest Service 2011)).

Veg-2. Erosion Prevention and Control. / BMP 1.3 – Use of Erosion Hazard Rating for Unit Design

- Resource protection measures are identified in the Project Design Features section of this report.
- High and very high erosion hazard areas are described in the soils section to appropriately implement resource protection measure in areas of concern to prevent downstream water quality impacts.
- Post-burn soil cover would be evaluated by an earth scientist to determine if objectives have been met and to recruit additional cover if necessary to minimize soil erosion.

Fire-1. Wildland Fire Management Planning / R5 BMP 6.1 – Fire and Fuel Management Activities

This BMP is designed to use the fire management planning process to develop measures to avoid, minimize or mitigate adverse effects to soil, water quality, and riparian resources during wildland fire management Fire 1activities.

The management requirements, mitigation measures, and multiple resource protection prescriptions are documented in the Project Design Features section of this report.

- The burn plan needs to consider prescription elements and ecosystem objectives at the appropriate scale to determine optimum and maximum burn unit size, total burn area, burn intensity, disturbance thresholds for local downstream water resources, area or length of water resources to be affected and contingency strategies.

- To minimize the potential for cumulative adverse effects when underburning, no more than ten percent of a sixth-field watershed (per fisheries design criteria) would be burned in any one year.
- Identify environmental conditions favorable for achieving desired condition or treatment objectives of the site while minimizing detrimental mechanical and heat disturbance to soil and water considering factors such as …desirable soil duff and fuel moisture levels, existing duff and humus depths, site factors suchj as slope and soil condtions, expected fire behavior and burn severity based on past experience in similar vegetation types.
- Extent and condition of trails, fuel breaks, and other resource activities and values.
- Develop burn objectives that avoid or minimize creating water repellent soil conditions to the extent practicable considering fuel load, fuel and soil moisture, fire residence times and burn intensity.
    - Use low intensity prescribed fire on steep slopes and highly erodible soils when prescribed fire is the only practicable means to obtain project objectives.

Fire-2. Use of Prescribed Fire / R5 BMP 6.2 – Consideration of Water Quality in Formulating Fire Prescriptions /R5 BMP 6.3 – Protection of Water Quality from Prescribed Burning Effects

This BMP is designed to avoid minimize or mitigate adverse effects of prescribed fire and associated activities on soil, water quality and riparian resources that may result from excessive soils soil disturbance as well as inputs of ash, sediment, nutrients, and debris.

- Locate access and staging areas near the project site but outside of Aquatic Management Zones (AMZs)[5], wetlands, and sensitive soil areas.
- Keep staging areas as small as possible while allowing for safe and efficient operations.
- Store fuel for ignition devices in areas away from surface water bodies and wetlands.
- Install suitable measures to minimize and control concentrated water flow and sediment from staging areas.
- Collect and properly dispose of trash and other solid waste.
- Conduct prescribed fires to minimize the residence time on the soil while meeting the burn objectives.
- Manage fire intensity to maintain target levels of soil temperature and duff and residual vegetative cover within the limits and at locations described in the prescribed fire plan.

- Rehabilitate or otherwise stabilize fireline in areas that pose a risk to water quality.
    - Fire line maintenance in areas underlain by ultramafic rock or soil (Figure 2) would be conducted during moist soil conditions to minimize dust generation.
    - Existing trails and hand lines used as fire lines would have erosion control structures constructed or reconstructed as needed following treatments to control surface flows and minimize off-site erosion.

[5] Aquatic Management Zones (AMZs) are an administratively designated zone adjacent to stream channels and other waterbodies. A variety of names for the AMZ concept are used in the States and Forest Service regions. For purposes of the National Core BMPs, these areas will be referred to as AMZs.

- Mulch hand lines that have less than 35 percent rock fragments with native materials such as fine slash, organic matter and duff. Existing trails used as fire lines only need water bars (no mulching).
- Installation of water bars on hand lines on ultramafic/Serpentine soils (Figure 2) will occur when soil moisture is sufficient to reduce hazard from Naturally Occurring Asbestos (NOA) (no or minimal dust created during water bar construction).
- Construct or reconstruct critical dips at all perennial stream crossings. Maintain 80 percent stream shade where it already exists.

- The burn plan will be reviewed by, and approved by the appropriate line officer.

Plan-2. Project Planning and Analysis / R5 BMP 7.8 – Cumulative Off-Site Watershed Effects

- Use suitable tools to analyze the potential for cumulative watershed effects (CWE) to occur from the additive impacts of the proposed project and past, present, and reasonably foreseeable future activities on NFS and neighboring lands within the project watersheds.
  - Cumulative Watershed Effects models (CWE models) that have been established for use in Region 5 of the Forest Service, and calibrated for use on the Shasta-Trinity National Forest, were utilized to analyze existing watershed conditions and the effects of the project. The results of CWE modeling show that the implementation of the project would not result in increased potential for adverse cumulative watershed effects.

PLANNING & IMPLEMENTATION CHECKLIST
Version 1.2
May 18, 2018

National Forest:	**Shasta-Trinity NF**
Ranger District:	**Trinity River management Unit**
Project type:	**Prescribed Fire**
Project name:	**Trinity Alps Prescribed Fire**
Watershed(s):	**New River**
6th field HUC(s):	**Eagle Creek, Six Mile Creek & Upper New River**
Start date:	**End Date:**
Project Officer	**Title:**

Project Officer Signature: ______________________________ **Date:** ________________

BMP Description	Design Measure	Implemented yes	Implemented no	Descriptions of Corrective Action Taken. Or If no, why?
FireA – Use of Prescribed Fire	Forms are attached in project record – these forms could be updated over time so it's a good idea to check with local hydrologist if forms provided are the most current.			
	Water drafting sites are designated on project map	☐	☐	
	Sufficient soil cover is maintained for erosion prevention as outlined in environmental document	☐	☐	
	Fire was backed down into RRs	☐	☐	
	Erosion control work specified in Project design features are in place for fire lines used in under burning activities	☐	☐	
	Soil cover guidelines were met post-fire	☐	☐	
	Low fire intensity (?) was maintained during prescribed fire activities	☐	☐	
	If needed, fuel piles were constructed outside of RR as outlined in environment document	☐	☐	
	Steep ground was avoided when piling fuel for prescribed burning	☐	☐	
	If needed, fuels were reduced in RRs to reduce	☐	☐	

BMP Description	Design Measure	Implemented		Descriptions of Corrective Action Taken. Or If no, why?
		yes	no	
	fire intensity during prescribed fire activities			
Other Water Quality Measures		☐	☐	
		☐	☐	
		☐	☐	
		☐	☐	

Comments or Additional Notes: